ISBN 978-967-0486-32-1

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9th ISSC

Contemporary Trends and Research in Sports, Exercise and Physical Education

9th International Sports Science Conference

25 - 28th June 2012 in Renaissance Hotel, Kota Bharu, Kelantan, Malaysia

Contemporary Trends & Research in Sports, Exercise and Physical Education

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Sports Science Unit

Contemporary Trends and Research in Sports, Exercise and Physical Education

9th International Sport Science Conference organised by
Sports Science Unit,
School of Medical Sciences,
Universiti Sains Malaysia

Published and distributed by:
Sports Science Unit,
School of Medical Sciences,
Universiti Sains Malaysia
16150 Kubang Kerian,
Kelantan, Malaysia
Tel: 609 7676933
Fax: 609 7641945
Website: http://www.medic.usm.my/ssu

ISBN 978-967-0486-32-1

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Development of the Elite Young Athlete

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Abstract

Success in youth sport is underpinned by a range of age-, growth- and maturation- related factors which influence performance in a sex- and sport-specific manner. Biological clocks run at different rates and boys who mature early are taller, heavier, and more muscular than boys of the same chronological age who mature later. Earlier maturing boys benefit from a marked increase in strength during late adolescence. The muscle enzyme profile needed to promote the anaerobic generation of energy is enhanced as children move through adolescence into young adulthood and this is reflected by a surge in anaerobic performance, particularly in boys. Aerobic fitness benefits from age and maturation-related increases in stroke volume and muscle mass. As selection for youth sport is based on chronological age, few later maturing boys are successful during early adolescence. Earlier maturing girls do experience an adolescent spurt in physiological variables such as muscle strength, muscle power and aerobic fitness which promote sport-performance but the differences in physical and physiological characteristics associated with maturity are less pronounced in girls than in boys. The linear physiques, with less weight for height, less fatness, relatively longer legs and lower hip-to-shoulder ratios of later maturing girls are more suitable for success in some sports. Elite young athletes present higher levels of fitness than their untrained peers. Young athletes of both sexes engage in intensive training from an early age but there is no convincing evidence to show that training affects the timing or tempo of growth and maturation. Coaches and scientists who work with young people should be aware of and alert to the effects of sex, age, growth, maturation and exercise training on sports performance. The emphasis must be on fostering participation in sport for all, indentifying talent, and nurturing it irrespective of the ticking of individual biological clocks.

INTRODUCTION

Participation in organized, competitive sport often begins as young as 6-7 years of age and elite young athletes often experience several years of high-level competition during childhood and adolescence. It is not unusual to see 2-3 year-old children participating in initiation programmes in sports such as gymnastics. Time engaged in training increases with age and elite young athletes in gymnastics or swimming might be training for ~30 hours or more each week by their early teens. Initial selection for, and retention in, elite youth sport takes place within a matrix of biocultural characteristics, which include health

status, family size, parental support, socio-economic status, and psychological readiness. However, performance in sport during youth is underpinned by a range of physical, biochemical and physiological factors which operate in a sport-specific manner and are dependent on individual biological clocks. This paper will review the effects of age, growth and maturation on sport performance during childhood and adolescence with particular reference to elite young athletes.

Growth and Maturation

All young people follow a similar pattern of growth and maturation but there are wide individual variations in the magnitude of growth and in the timing of the initiation and the rate of progress through puberty. Body size, body shape, and body composition are key components of success in chronological age-group sport and most elite young athletes have physiques that promote their sport performance.

During the first year of life body length increases by ~25cm with further growth in stature of ~12-13 cm during the second year. By age 2 years boys have attained ~50% of adult stature. Girls are always closer to their mature status than boys and reach ~50% of their adult stature by age 18 months. Thereafter, with the exception of a small mid-growth spurt between 6 and 8 years, there is a steady deceleration of growth rate to ~5-6 cm/y until the initiation of the adolescent growth spurt. The onset of girls' adolescent growth spurt occurs ~2 years earlier than that of boys with their peak height velocity (PHV) being reached, on average, between 11.3 and 12.2 years. Boys, on average, reach their PHV between 13.4 and 14.4 years. By PHV both sexes have attained ~92% of their adult height and growth rate decreases until adult stature is attained. With their extra 2 years of pre-adolescent growth (~10 cm) and greater magnitude of PHV (~3 cm) adult males are, on average, ~13 cm taller than adult females (Baxter-Jones, 2008).

Elite young female athletes in most sports (e.g. volleyball, rowing, swimming, tennis) have, on average, statures that equal or exceed the 50th percentile from childhood through adolescence. In contrast, gymnasts and figure skaters tend to be shorter than average. Similarly, elite young male athletes in most sports (e.g. tennis, ice hockey, swimming, rowing) are generally taller than their non-athletic peers although in some sports there is variation by playing position (e.g. soccer, basketball). Gymnastics is the only sport that consistently presents a profile of stature below the 50th percentile. With both sexes data on gymnasts must, however, be considered in the context of the selective criteria applied to this sport, including selection at an early age for small body size and physique characteristics associated with later maturation. There are no secure data to suggest that intensive training influences attained stature or rate of growth in stature (Malina, 1994).

Body mass quadruples by age 2 years and thereafter there is a slight but constantly accelerating rate of increase in mass prior to the adolescent growth spurt. The adolescent spurt in mass is similar to that of stature but normally occurs ~0.2-0.4 years later. The

increase in boys' body mass is primarily due to gains in muscle mass and skeletal tissue with fat mass declining from ~16% to ~12-14% of body mass. Peak muscle growth velocity (PMV) follows peak mass velocity and over the age range 7-17 years boys' relative muscle mass increases from ~42-54% of body mass. Young male athletes are normally thinner than their non-sporting peers but have body masses that equal or exceed the 50th percentile. During the growth spurt girls experience a rise in % fat mass from ~18-25% but elite young female athletes are generally leaner than their peers with values as low as 14% of their body composition as fat recorded in gymnasts. Girls' muscle mass increases from ~40-45% of body mass between 5-13 years but then, in relative terms, declines due to body fat accumulation during adolescence (Malina *et al.,* 2004).

During adolescence body shape changes and the effect on sport performance of differences in body shape becomes marked during late adolescence. Earlier maturing boys are generally taller, heavier, have higher mass-to-stature ratios, and broader shoulders than later maturing boys. In addition to greater body size, earlier maturing boys enjoy changes in body composition and shape that are advantageous in most sports. Increases in muscle size are reflected by strength increases and even small differences in shoulder breadth can result in large increases in upper trunk muscle. When, for example, greater upper body muscle is combined with the greater leverage of longer arms the advantages in throwing, racquet sports and rowing become readily apparent. The physical and physiological characteristics of earlier maturing boys at the same chronological age as later maturing boys enhance performance in most sports, particularly during the age range 13-16 years when participation in elite youth sport is at its peak. Since selection for youth sport is generally based on chronological age, few later maturing boys are successful during early adolescence, except in sports such as gymnastics (Armstrong & McManus, 2011).

Earlier maturing girls' greater hip breadths than later maturing girls is one of the reasons why they tend to throw out their heels when they run, as their thighs have to create a greater angle to bring their knees together. Earlier maturing girls have advantages over later maturing girls in sports that are reliant on body size and strength but their broader hips, relatively shorter legs and greater body fatness are characteristics which can be disadvantageous in some sports. Later maturing girls present linear physiques, less body fat, relatively longer legs, and lower hip-to-shoulder ratios which are more suitable for success in many sports. Earlier maturing girls are therefore less dominant than earlier maturing boys in youth sport. (McManus & Armstrong, 2011).

Muscle Strength

The maximal force that can be generated by skeletal muscle is primarily a function of muscle size and particularly of cross-sectional area but there is compelling evidence that during late adolescence a higher percentage of motor units can be voluntarily activated than during childhood. Muscles increase in size from early childhood reaching peak size during late adolescence or young adulthood. Growth hormone, somatomedins, insulin, myostatin

and thyroid hormones are important regulators of muscle growth but the dramatic increase in testosterone during male adolescence has the most crucial influence on muscle size. PMV occurs several months later than PHV and peak muscle strength growth velocity lags PHV by ~1.0-1.5 years. In addition, changes in muscle pennation with increased muscle size during adolescence positively influence the expression of strength in relation to muscle cross-sectional area (Williams *et al.,* 2012).

In boys, muscle strength increases linearly with chronological age from early childhood until ~13-14 years of age when there is a marked increase in strength through the pubertal years, followed by a slower increase into the early, mid or even late twenties. Superior strength often differentiates the elite young athlete from the less successful performer and provides a significant advantage to earlier maturing boys in many sports. Girls experience an almost linear increase in strength with age until ~14-15 years with no clear evidence of an adolescent spurt. Sex-related differences in strength have been reported in children as young as 3 years of age but differences are small prior to puberty and there is a considerable overlap of male and female scores. As girls tend to enter puberty ~2 years ahead of boys it is not unusual for 10 and 11 year-old girls to be stronger than similar aged boys. The prepubertal strength difference is, however, greatly magnified during late adolescence by which time very few girls outscore boys on strength measures. The sex-related difference is more marked in the arms and the trunk than in the legs, even after adjusting for body size differences. Correlations between measures of muscle strength from different muscle actions and/or muscle groups are generally quite low. Nevertheless, regardless of muscle action and whether individual strength or composite strength scores from several muscle groups are examined data describing the development of strength during growth and maturation are consistent and are illustrated using grip strength data in Figure 1 (De Ste Croix, 2008).

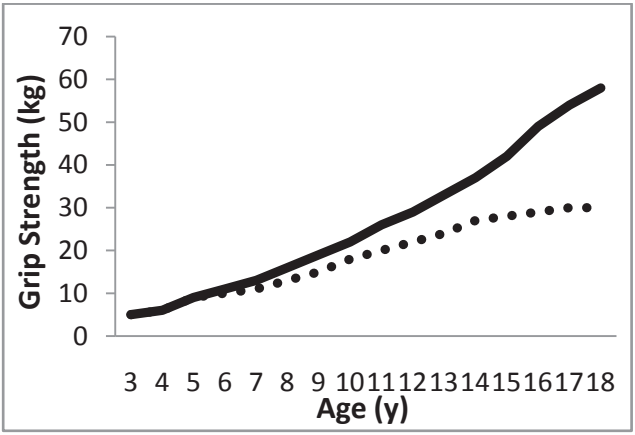

Figure 1: Grip strength in relation to age and sex. Boys solid line, girls dotted line.

Recent research has demonstrated that although resistance training is associated with risk of injury due to repetitive microtrauma to musculo-skeletal structures there is no compelling evidence to show that appropriately supervised resistance training is more likely to induce injury than participation in other sporting activities. Following resistance training pre-pubertal children normally experience similar (or greater) relative gains in muscle strength than adolescents and adults but smaller absolute gains. The mechanisms underlying training-induced changes in muscle strength vary with age, maturation and possibly sex. It is difficult to quantify the relative contribution of muscle hypertrophy and neurological adaptations such as enhanced neural drive, increased motor unit synchronisation and reduced central nervous system inhibition during youth. However, in pre-pubertal children strength gains can be principally attributed to neurological adaptations with muscle hypertrophy the dominant influence in late adolescence, particularly in boys. There are no, or only small, sex-related differences in response to resistance training among pre- and early- pubertal children although absolute muscle strength increases are likely to be more pronounced in boys during late adolescence and young adulthood. In sports where muscle strength is an asset, earlier maturing boys have distinct advantages over later maturing boys both in their superior strength due to maturation and their ability to enhance it further through training (Tolfrey, 2008; Ratel, 2011).

AEROBIC FITNESS

Peak oxygen uptake (peak VO_2) is the best single criterion of young people's aerobic fitness and young people's peak VO_2 has been well-documented over a 75 year period. Data show a progressive rise in boys' peak VO_2 (L/min) with age and girls demonstrate a similar but less consistent trend with a tendency to level-off from ~14 years of age (Figure 2). Between the ages 8 and 16 years, peak VO_2 increases by ~150% in boys and ~80% in girls respectively with the sex difference increasing from ~10% at age 10 years to ~35% by age 16 years (Armstrong & Welsman, 1994).

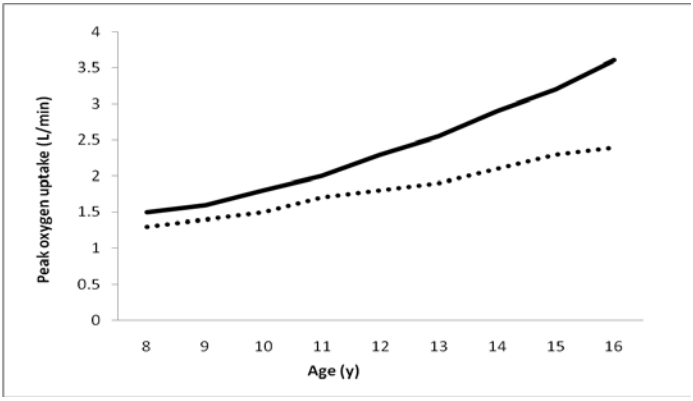

Figure 2: Peak oxygen uptake in relation to age and sex. Boys solid line, girls dotted line.

The increase in peak VO_2 with age reflects the increase in body size during the transition from childhood into young adulthood. When peak VO_2 is expressed in ratio with body mass (mL/kg/min) a different picture emerges from that apparent when absolute values (L/min) are used. Boys' mass-related peak VO_2 remains essentially unchanged at ~ 48-50 mL/kg/min^{-1} from 8-18 years, whilst girls' values decline from ~ 45-35 mL/kg/min over the same time period. Although mass-related peak VO_2 remains an important measure in relation to sports which require the movement of body mass, the use of this ratio standard has clouded physiological understanding of aerobic fitness during growth and maturation. Rather than removing the influence of body mass, ratio scaling 'over scales' thereby favoring light children and penalizing heavy children. When appropriately analysed the data show that, in conflict with the conventional interpretation (using ratio scaling), there is a progressive rise in peak VO_2 in both sexes independent of the influence of body mass (Welsman & Armstrong, 2008).

As young people grow they also mature and the physiological responses of adolescents must be considered in relation to biological as well as chronological age. Studies using appropriate statistical techniques have demonstrated that although fat free mass is the predominant influence in the increase of peak VO_2 through adolescence stage of maturation is an additional explanatory variable, independent of both chronological age and body mass. This gives earlier maturers an advantage over later maturers in performance in sports dependent on aerobic fitness (Armstrong et al., 2008).

Elite young athletes present peak VO_2 values ~30-50% higher than their non-athletic peers but this is likely to be due to both selection and training (Armstrong *et al.,* 2011). Genetic influences on the responsiveness of peak VO_2 to training are not well-understood but it appears that there is a continuum from high responders to non-responders. It has been hypothesised that there is a 'maturational threshold' or a 'trigger point' below which the effects of training will be minimal (Katch, 1983) but recent research using exercise intensities in the range 85-90% of maximum heart rate has demonstrated clearly that this is not the case and both prepubertal children and adolescents will respond to endurance training in a similar manner. The improvement in peak VO_2 through training is largely due to enhanced oxygen delivery to the muscles through an increase in maximum stroke volume (Armstrong & Barker, 2011).

SHORT-TERM HIGH INTENSITY EXERCISE

The ability to perform short-term high intensity exercise is important in virtually all sports but the difficulty of assessing and interpreting physiological variables under these conditions has limited understanding of the mechanisms underpinning performance. Research has focused on the assessment of external power output and variants of the Wingate anaerobic test (WAnT), which allow the determination of cycling peak power (CPP) have emerged as the most popular tests of young people's peak power output. Running peak power has been estimated (Sutton et al., 2000) but CPP is better documented

with young people. Cross-sectional data show that in both sexes, there is an almost linear increase in CPP with age over the range 7-13 years then, in boys but not girls, a second and steeper linear increase in CPP through to young adulthood is observed (Fig 3). Longitudinal data have emphasized the sex difference in power output in relation to age and maturation by showing 12 year- old boys and girls, respectively, to generate ~45% and ~60% of the CPP they achieved at 17 years of age (Armstrong et al., 2001; Van Praagh, 2000).

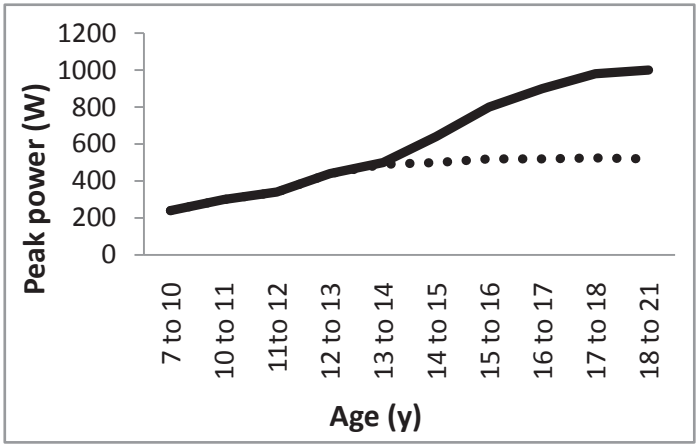

Figure 3: Peak power output in relation to age and sex. Boys solid line, girls dotted line.

The overlapping performance of girls and boys at ~12-13 years which is evident in Figure 3 is probably due to the girls being more mature than similarly aged boys. This was demonstrated in a study of 100 boys and 100 girls aged 12 years who had their CPP assessed using the WAnT. No significant sex difference in CPP was observed but when the children were classified into the stages of maturation described by Tanner (1962) it was noted that whereas the girls in Tanner stage 1 achieved 95% of the stage 1 boys' CPP the girls in Tanner stage 4 only achieved 87% of the stage 4 boys' CPP. Earlier maturing boys (Tanner stage 4) presented CPP values 66% higher than later maturing boys (Tanner stage 1). Earlier maturing girls (Tanner stage 4) presented CPP values 51% higher than later maturing girls (Tanner stage1). The children were all 12 years of age and with body mass also controlled, using allometry, there was a significant maturational effect on performance in both sexes although it was more marked in boys. These findings illustrate clearly the advantage of the earlier maturer in sporting events dependent on the expression of peak power output (Armstrong et al., 1997).

Compared with the extant data on training-induced changes in aerobic fitness data on the effects of high intensity training on power output are sparse. Most studies using laboratory power output tests such as the WAnT as the criterion measure have been short in duration and have not required the participants to train at maximal intensity. There are muscle biopsy

data which show that participation in a high-intensity training programme for 16 weeks can increase 11-13 year old boys' resting adenosine triphosphate (ATP), phosphocreatine (PCr), phosphofructokinase (PFK), and glycogen by 12%, 39%, 83%, and 32% respectively (Eriksson et al., 1973). There are no similar muscle biopsy data on girls. However, muscle biopsy studies tend not to be well-controlled and provide in vitro resting values on small samples of predominantly male participants. The influence of age and maturation on the trainability of maximal power output is therefore unclear (Tolfrey, 2008).

In a longitudinal study it was observed that, over the age range 12-17 years, CPP increased by 121% in boys and 66% in girls whereas increases in peak VO_2 were somewhat less at 70% and 50% for boys and girls respectively. These data indicate that there are age- and sex-related changes in predominantly anaerobic and predominantly aerobic performance which are asynchronous and suggest that during adolescence both sexes experience a greater increase in the ability to perform anaerobically than aerobically, with the effect more marked in males. However, metabolic profiles founded on CPP and peak VO_2 tests are the sum of numerous factors and do not provide the granulation of data required to tease out the subtle age- and maturation-related changes in exercise metabolism which support sport performance (Armstrong & Welsman, 2001; Armstrong et al., 2001).

DEVELOPMENTAL EXERCISE METABOLISM

Muscle Biopsy Studies

Boisseau and Delmarche (2000) suggested that maturation of skeletal muscle fibre patterns might account for age-related changes in the metabolic responses to exercise but, for both ethical and methodological reasons, the muscle biopsy technique has been used rarely with healthy children. The few muscle biopsy studies which have been performed with children have focused on resting and post-exercise measures and have generally been restricted to small samples of predominantly male children and adolescents. Nevertheless, some interesting patterns have emerged from the extant literature which infers that muscle fibre size increases with age from birth to adolescence and in males into young adulthood. The percentage of type I fibres in the vastus lateralis is a function of age, at least in males. The data indicate decreases in the percentage of type I fibres in healthy males over the age range 10-35 years. No clear age-related fibre distribution changes have been observed in females but this might be a methodological artifact as few data on girls and women are available (Jansson, 1996).

Studies comparing the muscle fibre composition of boys and girls are confounded by the small number of participants and large inter-individual variations which cloud statistical analyses. However, the literature shows a consistent trend with adolescent and young adult males exhibiting, on average, 8-15% more type I fibres in the vastus lateralis than similarly aged females in the same study (Armstrong & Fawkner, 2008).

Sport performances of varying intensities and durations are supported by different energy systems and the relative contribution of these systems is dependent on age and maturation. Direct knowledge of children's ATP, PCr, and glycogen stores is limited to a single muscle biopsy study of boys aged 11.6-15.5 years, reported by Eriksson and Saltin (1974). There are no comparable data on girls. Eriksson and Saltin's data indicate that resting ATP stores in the quadriceps femoris are very similar to values recorded by others in adults but PCr concentrations increase by 63% from age 11 to 16 years when they approach adult values. Muscle glycogen concentration at rest increases by 61% from 11 to 16 years when values are comparable to those of adults. Following heavy exercise, Eriksson and Saltin (1974) noted a decrease in glycogen concentration at all ages but the decrease was three times greater in the oldest compared to the youngest boys (Eriksson, 1980).

Enzyme activities measured at rest and in vitro do not necessarily reflect exercise in vivo conditions because interactions which influence the cytoplasmic and mitochondrial arrangement as a functionally complex system are neglected. However some insights are presented and pioneering research by Eriksson et al. (1974) described the levels of succinic dehydrogenase (SDH, an oxidative enzyme) and PFK (a glycolytic enzyme) activity at rest in the vastus lateralis of 5 boys, mean age 11.2 years. They observed SDH activity to be 20% higher and PFK activity to be 50% lower respectively than they had previously recorded for adults. Consistent with Eriksson et al.'s data, Haralambie (1979, 1980) observed higher activity in two oxidative enzymes in 11-14 year-old girls than in adults and lower activity of several glycolytic enzymes in prepubertal children compared to adults. In a subsequent study of 13-15 year-olds, however, Haralambie (1982) noted higher activity of oxidative enzymes in adolescents than adults but reported no significant difference in glycolytic enzymes activity between adolescents and adults. Berg et al. (1986) reported glycolytic enzymes activity to be positively correlated with age and oxidative enzymes activity to be negatively correlated with age over the age range 6-17 years although, with small sample sizes, the values did not reach statistical significance. Haralambie (1982) compared the resting activity of rate-limiting enzymes of glycolysis and the tricarboxylic acid cycle, namely PFK and isocitrate dehydrogenase (ICDH) respectively and calculated the ratio of PFK/ICDH activity to be 93% higher in adults than in adolescents. These findings were subsequently supported by Berg et al's (1986) data where the calculated ratio of glycolytic to oxidative enzyme activity (i.e. pyruvate kinase/fumarase activity) was 12% higher in adults than in 14 year-old adolescents, and 185%% higher in adults than in 6 year-old children. In adolescents the ratio was 154% higher than in children (Berg & Keul, 1988).

Magnetic Resonance Spectroscopy and Pulmonary Oxygen Uptake Kinetics Studies

Magnetic resonance spectroscopy using the phosphorus nucleus (^{31}P MRS) is able to interrogate the muscle and monitor ATP, PCr, and inorganic phosphate (Pi), in vivo during exercise. During exercise Pi increases with a corresponding decline in PCr and the expression of muscle Pi/PCr against power output provides an index of mitochondrial

function. The chemical shift of the Pi spectral peak relative to the PCr peak reflects the acidification of the muscle and allows the determination of the intracellular pH which gives an indication of muscle glycolytic activity. Incremental exercise results in non-linear changes in the ratio Pi/PCr plotted against power output and in pH plotted against power output. In both cases as power output increases, an initial shallow slope is followed by a second steeper slope and the transition point is known as the intracellular threshold (IT). Exercise below the Pi/PCr or pH IT which, in children, occurs at ~60% of peak power output, is termed moderate intensity exercise and above the Pi/PCr or pH IT high intensity exercise (Barker & Armstrong, 2010).

During incremental quadriceps exercise to exhaustion, with power output normalized to quadriceps muscle mass, it has been observed that, during exercise above the ITs age-related differences in the muscle phosphates and pH are present with adult men and women exhibiting a greater anaerobic contribution to exercise metabolism than boys and girls. Maturational effects on metabolism were not demonstrated in boys, aged 9-12 years, however, similarly aged but earlier maturing girls displayed pH dynamics akin to those of adult women. The lack of a maturational relationship in the boys is probably due to the boys in the study being prepubertal or early pubertal (Barker et al., 2010).

Incremental exercise is a useful laboratory model but not representative of sporting performance. PCr kinetics, however, are important for all sports which require rapid step changes in exercise intensity (e.g. changes of pace in soccer). To date only two published ^{31}P MRS studies have examined age-related differences in PCr kinetics during a transition from rest to exercise. During step changes at the onset of exercise both below and above the Pi/PCr IT no significant age- or sex- related differences in PCr kinetics were detected (Barker et al., 2008a, Willcocks et al., 2010). However, it is worth noting that during the transition to high intensity exercise 24-30% differences in PCr time constants were reported between boys and men which while not statistically different infer possible biological significance. Furthermore, unpublished data from my laboratory indicate that boys have significantly faster PCr time constants than men in response to the onset of very high-intensity exercise (Willcocks et al., unpublished PhD thesis, 2011).

Children's pulmonary oxygen uptake (pVO_2) kinetics during upright cycle ergometer exercise has been demonstrated to closely reflect their PCr kinetics during prone quadriceps exercise. The study of pVO2 kinetics therefore provides a window through which muscle can be interrogated during exercise (Barker et al., 2008a).

During both moderate and high intensity exercise the pVO_2 kinetic response to a step change in exercise intensity is significantly faster in children compared with adults, resulting in a smaller absolute and relative oxygen deficit. During a transition to high intensity exercise boys' pVO_2 kinetic response is faster than that of girls. Children's faster increase in pVO_2 to a new steady-state and therefore lower contribution to ATP re-synthesis from anaerobic sources during the non-steady state reflects a more efficient oxygen delivery

system, enhanced oxygen utilization or both compared to adults. During high intensity exercise the magnitude of the pVO_2 slow component is reduced in children compared to adults and in boys compared to girls. This is consistent with an age-related decline in the % of type 1 muscle fibres and the noted sex differences are in accord with boys having a higher % of type 1 fibres than similarly aged girls (Fawkner & Armstrong, 2003; Armstrong & Barker 2009).

Summary of Studies of Developmental Exercise Metabolism

Data from muscle biopsy, ^{31}P MRS and pVO_2 kinetics studies are in general accord. On balance the muscle biopsy data indicate that in terms of enzyme activity and high energy phosphate stores children are disadvantaged compared to adults in short-duration, high intensity activities but appear well-equipped for low to moderate intensity activities predominantly supported by aerobic metabolism. Earlier maturers are advantaged over later maturers in sports dependent on short bursts of high intensity activity. Studies using ^{31}P MRS and pVO_2 kinetics to interrogate muscles indicate a developmental influence on the mitochondrial oxygen utilization potential that supports enhanced oxidative function during childhood (Armstrong & Barker, 2012).

CONCLUSION

Performance in sport during childhood and adolescence is dependent on a range of physical and physiological variables which are age-, growth-, maturation- and sex-related. Earlier maturing boys are generally taller, heavier, and more muscular than boys of the same chronological age who mature later. Earlier maturing boys also benefit from changes in body shape which are advantageous in many sports. In some sports earlier maturing girls benefit from enhanced size and muscle strength compared to similar aged later maturing girls but in other sports the body shape and size of later maturing girls is advantageous. Increases in muscle strength and power output with age are apparent in both sexes during adolescence but the changes are much more marked in boys. With age and body mass appropriately controlled maturation exerts a significant additional positive effect on muscle strength and power output which benefits earlier maturers. The muscle enzyme profile needed to promote the anaerobic generation of energy is enhanced as boys and girls move from childhood through adolescence into young adulthood. Peak VO_2 increases with fat free body mass but additionally benefits from age- and maturation- related increases which are more marked in boys. Children and adolescents of both sexes improve performance with training and there is no evidence to suggest that endurance, high intensity or resistance training adversely affects growth and maturation.

Further research is necessary to tease out the underlying physiological factors determining elite sport performance during youth. The development of techniques and technologies, such as ^{31}P MRS and breath- by- breath respiratory gas kinetics, has unleashed the potential

to provide new insights into the mechanisms underlying performance but few studies have included elite young athletes.

Many young people achieve success in youth sport but other talented children are denied access to elite age-grouped sport through selection policies which are influenced by factors related to growth and maturation. Other youngsters drop-out prematurely through ill-advised early specialization in sports which turn out to be inappropriate for their late adolescent physiology or physique. Coaches and scientists who work with young people should be aware of and alert to the effects of sex, age, growth, maturation and exercise training on sports performance. A successful journey from school playground to Olympic podium is ultimately dependent on fostering participation in sport for all, indentifying talent, and nurturing it irrespective of the ticking of individual biological clocks.

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Challenges of Developing Malaysian World Class Athletes

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Abstract

The Malaysian public through expressions of desire, and the Government through enunciation of a National Sports Policy leave no doubt that this 50 plus old independent nation has aspirations that its sportspersons rank amongst the elite regionally if not globally. This is no idle aspiration as the nation has proven a number of times over and in fact continues to do so, that we have athletes who have become world champions. But, we want more. More in terms of sports that are more universally practiced and more in terms of consistency and sustainability. However this does not come without a price tag, not just in monetary terms but in individual and societal commitment and effort. To continuously throw up world class athletes across a wide array of sports, a systematic approach is needed and the ingredients will be best understood if we were to see sports success as being dependant in the contents of three concentric circles. The innermost is the individual –characterised by his genetic endowment, his acquisition of the appropriate skills, and his application of these to ensure victory. The next circle represents the support group that ensures his selection, preparation, care and maintenance. These will encompass the support he needs receive from talent identification to talent development through coaching, sports science, sports medicine and the like. And finally the last circle refers to the most opaque of the three circles, and certainly the least addressed, namely what I would like to refer to as the "social determinants' of success. The challenge is to ensure that there is a holistic approach to the fulfilment of the requirements of the three circles, overcoming temptation to address only the symptoms and not the underlying causes of shortfalls in outcomes. This paper will attempt to deal with the challenges that need to be overcome in realising this holistic approach in general and within the Malaysian context in particular. Examples will be drawn from and comparisons made with other countries which consistently achieve international success in sports

Application of Biomechanics to Elite Sports Performance

Case of Olympic Gold Medal Hammer Thrower, Dr. Koji Murofushi

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Abstract

Koji Murofushi is a male hammer thrower with a personal best of 84.86 m. This was achieved in 2003, and it stands as the present Asian record. He won a gold medal at the 2004 Athens Olympic Games and the 2011 World Championship in Korea. Since 1993, when he was 19 years old, we have recorded his throwing motion in competitions several times each year and analyzed the same in three dimensions. Dr. Murofoshi's throwing motion is characterized by special features that are distinct from those of other elite throwers, such as higher hammer head speed in the early stages, faster and more continuous movement of the center of gravity (CG) of his body, and shorter radius of curvature. Apart from his career as an elite athlete, he was pursuing a PhD in biomechanics. He has developed a new system that determines changes in the speed and the radius of curvature of a hammer head using sensors (accelerometers and force transducers) attached to the hammer cable. The amount of time required for analysis was shortened considerably by the use of a hammer with sensors compared to ordinary video analysis. Therefore, the developed system will ensure that athletes and coaches receive quick feedback. He obtained a Ph.D. in 2007 with a dissertation titled "Biomechanical Study of Hammer Head Acceleration." In this manuscript, the motion analysis results of his throws and a part of his Ph.D. research work are introduced. Then, the implications of elite athletes studying and conducting research in the field of sport sciences are discussed.

INTRODUCTION

Since Lapp's classic research work was published in 1935, considerable attention has been focused on the biomechanical analysis of hammer throw motion. A biomechanics research project team comprising more than 70 researchers was assembled for the 3rd IAAF World Athletics Championships held in Tokyo in 1991. We filmed all events with high-speed cinematic cameras and published reports and videos for coaching purposes (Sasaki et al, 1994). At that time, I was one of the members on the research team for analyzing the throwing events and have been involved in the biomechanical analysis of hammer throw ever since.

In 1991, when the IAAF World Athletics Championships were held in Tokyo, Koji Murofushi, then 19 years old, started his athletic career as a hammer thrower. He went on to break his own record almost every year and eventually achieved his personal best (PB) throw of 84.86 m in 2003 (figure 1). Dr. Murofushi won gold medals in the 2004 Athens Olympics and the 2011 World Championship in Korea.

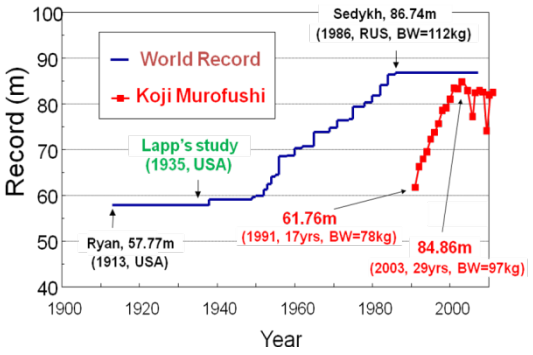

Figure 1: Changes in the world record, and Koji Murofushi's annual best records

STUDY OF MUROFUSHI'S MOTION

Koji Murofushi's throwing motion in actual track and field meets was recorded with three-dimensional high-speed cinematography or videography using two synchronized cameras at a recording frequency of 200 or 250 Hz. The obtained images were analyzed using direct linear transformation (DLT) procedures (Abdel-Aziz and Karara, 1971), and various parameters such as the release conditions (initial speed, release angle, and height) of the hammer head and the changes in the center of gravity (CG) position of the thrower's body were obtained.

His throwing motion is characterized by several special features that are distinct from those of other elite throwers such as world record holder Sedykh (RUS) and Barcelona Olympic gold medal winner Abduvaliev (TJK). These special motion characteristics include higher speed of the hammer head in the early stages of throw, faster and more continuous CG movement (figure 2), and shorter radius of curvature throughout the motion (figure 3). Most of these differentiating features can be ascribed to Dr. Murofushi's lighter body weight than the other elite throwers.

Throwing distance is directly proportional to head speed at the instant of release. Consequently, if two athletes release the hammer with identical head speeds, their throwing distances would be very similar. The physical variables are related as follows:

$$\text{Centrifugal Force} = \text{Mass} * (\text{Head Speed})^2/\text{Radius of Curvature}$$

Therefore, centrifugal force is inversely proportional to the radius of curvature. A large centrifugal force could disturb stable motion, particularly in the case of Koji Murofushi, whose throwing style emphasizes dynamic balance ability.

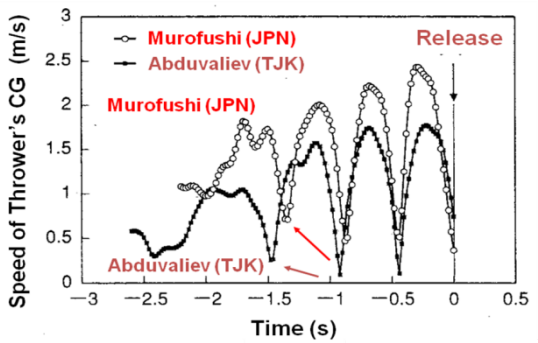

Figure 2: Changes in body CG speed during throw: comparison between Murofushi and Abduvaliev

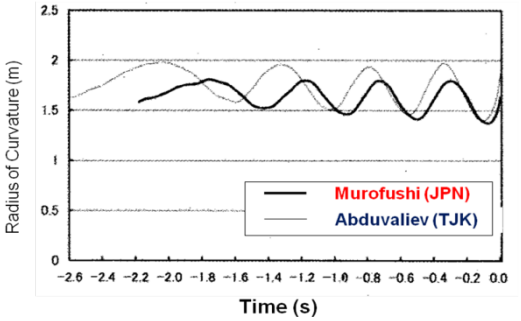

Figure 3: Changes in radius of curvature during throw: comparison between Murofushi and Abduvaliev

KOJI MUROFUSHI'S PhD DISSERTATION

Koji Murofushi's interest in biomechanics research drove him to analyze his throwing motion. Specifically, he was interested in the shorter radius of curvature, and the consequent larger centrifugal force on the hammer cable, of his throw compared with other elite athletes. After earning an undergraduate and a master degree at Chukyo University, Koji Murofushi earned a PhD in 2007 with a dissertation titled "Biomechanical Study of Hammer Head Acceleration." The dissertation consisted of two studies, as follows, and both studies were published before he was awarded the PhD.

Study 1:

Development of a system to measure radius of curvature and speed of hammer head during turns in hammer throw

Koji Murofushi, Shinji Sakurai, Koji Umegaki, and Kazutoshi Kobayashi

International Journal of Sport and Health Sciences, Vol. 3, 116-128, 2005

This study aimed to develop a system for determining the changes in the radius of curvature and hammer head speed using sensors (accelerometers and force transducers) attached to the hammer cable (figure 4). The subject was a Japanese national record holder (Koji Murofushi, PB of 83.47 m at the time of investigation). He threw the hammer with the attached sensors. The attached sensors were as follows: a tension meter comprising a metal plate with affixed strain gauges that measured the force exerted along the length of the hammer cable, and two integrated circuit (IC) accelerometers whose axes were aligned along the hammer cable that measured the angular velocity perpendicular to the hammer cable. The radius of curvature and speed obtained using these sensors were similar to those obtained from video analysis in magnitude but they were slightly out of phase (figure 5). This is because the sensors measuring the angular velocity eliminate translational motion and generate results for only rotational motion. The time required to obtain the results using a hammer with attached sensors was considerably shorter than that required with conventional video analysis. Therefore, the developed system enables quick feedback of the results to athletes and coaches.

Figure 4: Developed system (top) and on-site photographs (bottom)

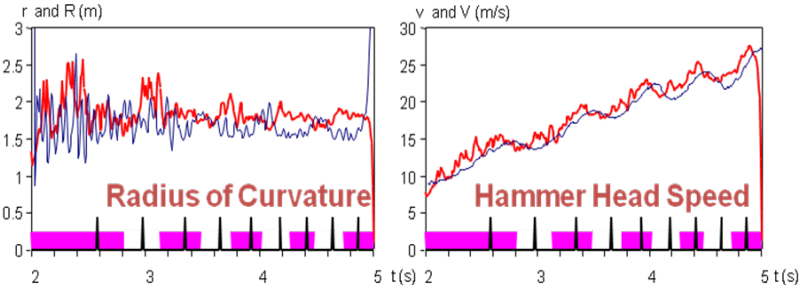

Figure 5: Comparison of changes in radius of curvature (left) and speed (right) of hammer head between two methods: video analysis and the newly developed sensor hammer system

Study 2:
Hammer acceleration due to thrower and hammer movement patterns
Koji Murofushi, Shinji Sakurai, Koji Umegaki, and Junji Takamatsu
Sports Biomechanics, Vol. 6, 301-314, 2007

Ground reaction force and hammer cable tensions were measured during indoor test throws by three throwers: Asian record holder Koji Murofushi (PB = 84.86 m) and two university athletes (Athletes B and C with PBs of 59.95 m and 46.30 m, respectively). The throwers were filmed using three high-speed video cameras (250 Hz). Displacements of the hammer head and the athletes' centers of mass were determined by three-dimensional analysis. Vertical fluctuations in Athlete A's center of mass and the hammer head during the final two turns before release revealed an inverse relationship between the hammer high point and the thrower's low point about the hammer's azimuth angle (figure 6). The half-a-turn of a synchronicity between the thrower's and the hammer's movements was ascribed to the time required to accelerate the hammer head; this is similar to the manner in which the amplitude of a pendulum increases when it is pulled upward by a string against the downward movement of the swinging weight.

Dr. Murofushi continues his research activity alongside his participation in international competitions; in the 2012 London Olympic Games, he won the Bronze medal with a throw of 78.71 m. One of his recent interests has been the development of a system with audio feedback for changes in physical parameters such as hammer cable tension, and speed and radius of curvature of the hammer head. He is attempting to determine the acceleration mechanism of hammer heads using an infrared, three-dimensional motion capture system.

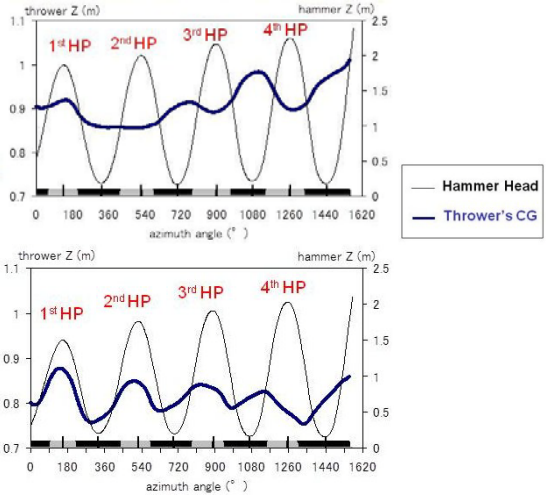

Figure 6: Changes in heights of hammer head and thrower's CG: comparison between Koji Murofushi (top) and subject C (PB = 46.30 m, bottom)

CONCLUSION

In many countries, including Japan, many elite athletes are applying for admission into undergraduate and graduate sports science programs. The knowledge gained through research in various sports science fields, including biomechanics, may contribute directly to improvements in sports performance. However, it seems there is another meaning and means for sports science to enhance sports performance. It could indirectly contribute for it.

It takes 10–15 years for coaches to train young sportspersons to the level of elite athletes. Coaches are likely to superficially emulate the methods used by current sporting champions. However, such training methods may be obsolete by the time the trainee players reach the elite stage, thus reducing the effectiveness of such training. Therefore, it is desirable that coaches and athletes be more flexible in the adoption of training methods and open to studying the human body and its movements.

Sportspersons should be creative and curious about everything, in other words, adopt a "scientific" temperament. Originality and inventiveness of training methods and skill-acquisition procedures are essential for future elite athletes.

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Diet, Diabetes and Cancer – How and Why?

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Abstract

Both diabetes and cancer are prevalent diseases whose incidence is increasing globally. While few cancers are unavoidable because the genetic abnormality is inherited, in a large majority, cancers could be avoided. The acquired genetic abnormality in most instances is 'self-inflicted' such as fatty diet, tobacco smoking, alcohol, obesity, physical inactivity etc. Cancer and diabetes are diagnosed within the same individual more frequently than would be expected by chance, even after adjusting for age. Both diseases are complex, with multiple subtypes. The cause of cancer is multi-factorial. It is a genetic disease. A series of recent studies and meta-analyses confirm that the risk for several solid and hematologic malignancies (including liver, pancreas, colorectal, kidney, bladder, endometrial, breast cancers, and non-Hodgkin's lymphoma) is elevated in diabetic patients. Most studies on the association between cancer and diabetes have been carried out in patients with type 2 diabetes (90% of all diabetic patients). As these patients, unlike those with type 1 diabetes, have endogenous hyperinsulinemia and insulin resistance. Type 2 diabetes and cancer share many risk factors; such as aging, obesity, diet, and physical inactivity. Other than hyperinsulinemia, hyperglycemia, and inflammation have also be included as possible mechanisms. Hyperinsulinemia most likely is the initiating cause of cancer as insulin is a growth as well as a mitogenic factor. Its action in malignant cells is favored by mechanisms acting at both the receptor and post-receptor level. Obesity, hyperglycemia, and increased oxidative stress may also contribute to increased cancer risk in diabetes. The findings of our research in this area will also be shared.

CANCER – GLOBAL PREVALENCE [Figure 1]

Cancer trends are showing upward trends in many developing countries (Lepage, et al., 2008; Lim, 2002; Yeole, 2008) and a mixed pattern in developed countries (Bouchardy, et al., 2008; Kabir & Clancy, 2006; Westlake & Cooper, 2008). By 2050, the cancer burden could reach 24 million cases per year worldwide, with 17 million cases occurring in developing countries (Parkin, Bray, & Devesa, 2001). Cancers which are associated with diet and life-style are seen more in developed countries while cancers which are due to infections are more in developing countries. In Malaysia, death due to cancer was ranked 3rd (10.11%) after heart disease (14.31%) and septicemia (16.54%) in 2005. According to World Health Organization (WHO) death from cancer is expected to increase to 104% worldwide by 2020. Largest impact being in developing countries in comparison to developed countries (Rastogi, Hildesheim, & Sinha, 2004).

The most important change that would occur in the world population in the next 50 years is the change in the proportion of elderly people (more than 65 years); 7% in 2000 to 16% in 2050(Bray & Moller, 2006). According to Department of statistics Malaysia, the life expectancy for males and females in Malaysia increases by 0.1-0.5 year annually since 2005("Key Statistics by Department of statistics Malaysia," 2008). Many cancers are associated with aging, although age per se is not an important determinant of cancer risk, it implies prolonged exposure to carcinogen (Franceschi & La Vecchia, 2001). By the year 2050, 27 million people are projected to have cancer. More than half of the estimated number will be residents of developing countries (Bray & Moller, 2006).

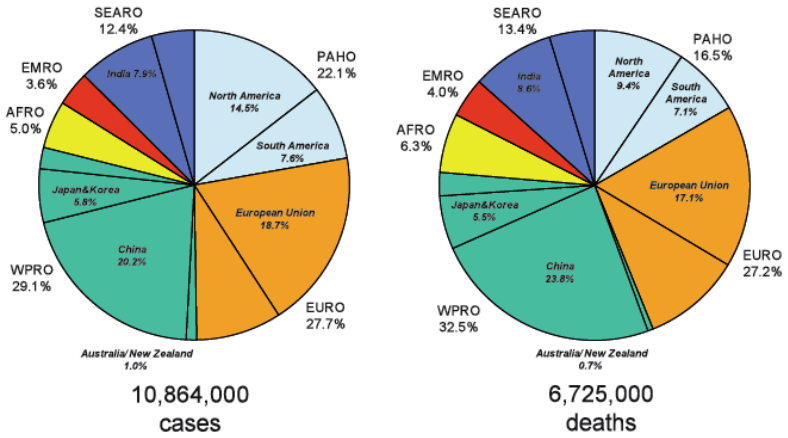

Figure 1: Incidence and mortality in the six WHO world areas [source: World cancer burden 2008]

DIET AND CANCER [Table 1]

The association of diet on certain cancers is well established. However in most instances the mechanism is through obesity and diabetes. Often incriminating certain food/diet to a certain cancer is by doing observation on large study populations. Most of the associations are derived from food survey. Matched controlled research to incriminate certain foodstuff to have certain cancer risk is mostly done in animals and conducting them on human is unethical. Employing innovative technologies to improve accuracy in recollection on what is taken in within 24 hours did not improve accuracy in measuring diet in nutritional epidemiology (Illner, et al., 2012). Having said that there are certain diets with certain cancer risk, such as alcohol, tobacco, low fiber diet [Table 2]. For those who like to eat meat, possible approaches to reduce cancer risk are by trimming fat off the meat, eat meat with high intake of vegetables, fruits and cereals as the efficacy of formation of NOC is reduced by high levels of vitamins C or E and reduce high overall dietary iron intake. Recent studies have shown that diet is modestly associated with breast cancer risk; associations appear more pronounced for postmenopausal disease (Thomson, 2012).

Table 1: Foodstuffs, lifestyle habits and risk of colorectal, breast and prostate cancer. [Ref: World cancer Report 2008]

	Colorectal cancer (CRC)		Breast cancer		Prostate cancer	
Increases in intakes of	Change in risk	Types of studies	Change in risk	Type of studies	Change in risk	Type of studies
Red meat, processed meat	Small increase	Review and cohorts	No sufficient data	Review	No change	Cohorts
Alcohol	Small increase	Review, MetaA	Increase risk	MetaA	No change	Review
Overweight/ obesity	Increase	MetaA, Review	Increase after menopause	MetaA, Review	No change	MetaA, Review
Lack of physical activity	Increase (for colon cancer)	Review	Increase, mainly after menopause	Review	Small increase	Review

Table 2: 'Bad' verses 'good' diet for/ against cancer risk

'Bad' diet [risk or getting cancer]	'Good' diet [protective against cancer]
• High fat, cholesterol, saturated fat • High calorie • Alcohol • Preserved foods (pickles) • Iron overload [too much red meat] • Vitamins and minerals deficiency	• Energy restriction • Macronutrients • Fiber • omega-3 fatty acid • Micronutrients • vitamins: A, D, E,C, B6, folic acid • Minerals: Ca, Se, Zn, • Non-nutrients (phytochemicals) • Honey

DIABETES AND CANCER

With the growing economic affluence of any nation, some health problems ensue (Popkin, 2007). The improvement in the socio-economic status of the people of Kelantan has contributed to the increasing prevalence of diabetes, obesity, smoking and other life-style diseases such as coronary artery diseases and hypertension (Mafauzy, Mokhtar, & Wan Mohamad, 2003; Rahman, Rahman, Ismail, & Rashid, 2007). These life-style diseases are the probable causes of the rising trend of cancer in the population. Obesity is closely related with diabetes (Grandone, et al., 2008). In a community that has high prevalence of obesity also has high prevalence of diabetes (Othman, Nor, & Biswal, 2008). In Kelantan, Malaysia the prevalence of diabetes in 1999 was 10.5% and impaired glucose tolerance was 16.5% (Mafauzy, Mokhtar, Mohamad, & Musalmah, 1999). Kelantan is ranked highest in prevalence of diabetes in Malaysia in which the overall national prevalence is 8.3 %(Zaini,

2000) thus it was not a surprise to see a rapid rise of cancer prevalence in the state (Othman, et al., 2008). According to a review on diabetes, WHO has estimated that by 2030, there would be 2.48 million diabetics in Malaysia, a jump of 164% from 0.94 million in 2002 (Mafauzy, 2006). One of the most common cancers noted in community that has high diabetics and obesity is colorectal cancer (Ahmed, Schmitz, Anderson, Rosamond, & Folsom, 2006; Othman & Zin, 2008; Seow, Yuan, Koh, Lee, & Yu, 2006; Yang, Hennessy, & Lewis, 2005).
In a study of 138 colorectal cancers (CRC) seen in Hospital Universiti Sains Malaysia, 47.8% had metabolic diseases, of which 13.8% were diabetes type 2(Othman & Zin, 2008). Those diabetics with CRC often have distal cancers (Othman & Zin, 2008).

MECHANISMS OF DIETARY FATS AND CANCERS

There are 3 possible mechanisms; a) mediated by bile acids (colon cancer). Any factors which affect the nature, secretion, solubility and dilution of bile acids in the GI tract will give risk to formation of colon cancer. b) mediated by hormones (breast). The estrogen and progesteron hormone increase mammary cell growth and proliferation, fat promotes the effectiveness of estrogen and progesterone on mammary cell growth and fat is converted to estrogen in postmenopausal women. c) mediated by prostaglandins (breast). In this, fat leads to increase formation of various types of prostaglandins. Linoleic acid $\rightarrow$arachidonic acid $\rightarrow PGH_2$, PGI_2, PGD_2, PGE_2, PGF_2 which influence cell metabolic activity, growth and migration of tumour cells$\rightarrow$tumor promotion and metastases.

MECHANISMS OF DIETARY FIBRE AND CANCER

There are several postulations such as rich fiber diet leads to decrease intestinal transit time, decrease time for contact of carcinogens with the colonic tissue, dilute carcinogens and bile acids (Promoter of carcinogen) in the gut, change the bacterial flora and fermentation capability. Too much fiber may itself injury the mucosa of the colon and enhance carcinogenesis.

MECHANISMS OF DIABETES AND CANCER

Diabetics type 2 are in chronic state of hyperinsulinaemia. Insulin is a growth factor and is mitogenic to epithelial cells. High glucose is also mutagenic to cells. With time the pancreas will be damaged, thus there is a decrease insulin secretion due to failure β-cells. Patients may require exogenous insulin however the damage may have already set in. Hyperinsulinaemia is responsible for initiation, promotion, progression phase in carcinogenesis steps. Diabetics are often obese, have low immune status, have chronic infection, increased oxidative stress which is at risk of cancer formation.

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Sport Psychology: A Conceptual Framework and a Means for Building Healthier Communities

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Abstract

A body of knowledge in the area of Sport Psychology is still in the making. There still a need for a concise definition of practices and even of who are the professionals able to orient the practice. An ever more important role of sports in our societies constitutes a challenge to various related fields, from the athletes' viewpoint to the sports industry and organizations, and to other related areas. In this sense, society may profit with the consolidation of a conceptual framework in sports psychology. Furthermore, the practice, teaching, and development of sports are keys to child, adolescent, and human development. Schools, universities, and communities have a stake in understanding the psychological issues involved in the professional or recreational forms of doing sports. This text analyzes the field of sports psychology from a historical and cultural perspective, emphasizing the need for more discussion among different sectors involved in the field of sports and calling attention to sports psychology as a tool for societal structuring and for building healthier communities.
KEYWORDS: Sport psychology; community health; intersectorial work.

INTRODUCTION

The last few decades have testified the increasingly prominent role of psychological factors in the practice and performance of sports (Anderson, 2000; Thompson, Van Raalte& Brewer, 2011; Thompson, Vernacchia, & Moore, 1998). The higher the level of preparation of athletes, the more they need to balance physical, technical, tactical, and psychological capacities. Sports demand strong dedication, long hours and extended days of work, putting the athletes under a high degree of physical and psychological strain.

Several levels of relationships, from interpersonal to social and professional, influence sports performance. Coaches, sport club directors, the media, fans, family, and friends, are all together working, helping, demanding, supporting, and otherwise involved in the intricate universe of sport practice. The athletes need physical and mental strength, as well as social and interpersonal abilities in order to deal with the pressures imposed by the lifestyle inherent to the sport business which is, in the end, reduced to the pursue of expected performances. In this context, competition and self confidence are key words and the self is always in a mode of vulnerability (Williams Straub, 2001).

However, sports are not only about professionalism, competition, and high performance. Sports have been perceived as a tool for achieving good health, both physical and psychological and, overall, a good life. Sports have been used as a strategy for getting youth

away from bad habits, including using drugs, alcohol, and cigarettes, as well as keeping them occupied during out of school hours, preventing their involvement in violence and other social problems. Also recognized is the role of sports in the development of young children. Involvement with sports in early ages brings opportunities to challenging, stimulating, and living through pleasurable experiences, if practices are offered in the right time, under the right conditions and with the appropriate demands considering the child´s age (NCEE, 1983). An ever more perceived need for a better understanding of sports in its different roles in human development and human relationships is indeed in place. Professional, competitive, high performance, school, community, and recreational sports have thus come to constitute a field of knowledge of the highest importance. The improvement of knowledge in this field can be a most important component in the weaving of healthier communities. Such a field is not definitely established and it needs to be nurtured and crafted.

Delineating the field of Sport Psychology

Sport Psychology (SP) is a relatively new field of knowledge. The creation of an International Society of SP occurred in 1965 in Rome. This occurs at the time when sports have become an important part of human life at least for 2,000 years in the Western societies. This creation reflects an interest of the scholarly world mainly represented in the domains of Physical Education, Sports Science, Physiology, Biomechanics, Leisure, Psychology, and the Humanities. Late comers into this field have been the Health sciences and Law, among others.

The history of SP shows much earlier works such as Triplett´s (1897) studies on the influence of spectator on the performance of bicyclists, considered by some as the first publication in the field of Social Psychology (West & Wicklund, 1980). The works of G. Stanley Hall (1908), founder and president of the North American Psychology Society, Schulte´s (1924) "Body and soul in sports: an introduction to the psychology of physical exercise" and Griffith´s (1926) "Psychology of training", immediately followed by "The psychology of athletics" were in tune with the foundation, in 1925, of the Laboratory of Psychology applied to Sports, where several studies were conducted around the issues of psycho-motor learning, personality, and motivation. By the same token, the Soviet Union demonstrated an early and general interest in sports and in SP. These may have been reflected in the strong representation of the USSR in the Olympic Games throughout the 20th century.

The SP studies published by Lawther in 1951 became a landmark in the field. By the 1970s SP started to be more strongly represented in the academic community through the establishment of academic departments and the appearance of several regular periodicals specifically dedicated to the field. Looking into its trajectory, we can see that SP started in strong relationship with the field of Physical Education which led it into the Physiology laboratories, jeopardizing the development of a stronger link with departments of Psychology. As a consequence, SP has turned its eyes mainly to the study of biological conditions and to the improvement of performance (Machado, 2006). To this day we can observe, in practical terms, a strong dichotomy, with a prevalence of studies in the areas of physiology and kinesiology, conducted for the most part in the Physical Education academic arena, comparing to the presence of departments of psychology in studying sports (Feltz, 1992).

This has also become a problem for the development of Physical Education, as in this arena, sports have not been studied from a more integrative, holistic perspective. This dichotomization has contributed to the practical separation of the technical-tactical professionals. Guided by the physiological-kinesiological paradigm, the psychological teams today, even though their expertise are highly requested, they are confronting many barriers related not only to the intrinsic distance created among them, but also by the inevitable view, from the standpoint of traditional professionals, whom regard the psychological teams as minors in terms of their scientific and otherwise contributing roles.

Mapping the psychological issues

The picture, therefore, is of a field that engendered a hegemony that guides to the advancement of sports itself. This hegemony affirms itself at a time when our society has become oriented by a market mentality and performance and sports have been given a commercial value under the market economy. Athletes are not anymore living the Olympic ideals to the fullest but are to a great extent committed to professional goals often directly linked to the interests of their corporate sponsors. Many psychological issues enter this picture and the psychological pressures put on athletes point to a need of a well developed psychology of sports.

On the other hand, society has created new roles for sports, for instance in health promotion, disease prevention, youthwork, child and youth development, leisure, and community organization. These new roles bring about other sets of problems and expectations, calling for different attitudes, evoking different values, and proposing different kinds of behaviors. From the point of view of child development, for instance, one may argue that we actually have to counterpoint the idea of competition, which is central in the paradigm that orients high performance, professional sports, and the market mentality. Even if one sees competition as somewhat valid in school sports, community games, and in some health promotion activities, we are talking about another kind of behavior in the context of another kind of competition. While this is easy to accept and talk about, it becomes a real problem when educators, health professionals, and community leaders face the necessary re-examination of values, beliefs, attitudes and behaviors traditionally mediating the practice of sports at all levels. The same problem applies to the re-examination and re-contextualization of concepts such as individualism, collaboration, team work, and success. These issues, by their very nature, call for a better understanding of the psychological dimension of sports.

The domain of sports, including its psychological dimensions, has been further complicated by territorial disputes, corporative interests, and professional clashes. This has made even more difficult to organize the field and foster collaboration among internal areas. On the other hand, there is a wide open terrain for the practice of SP, if we think it as useful in areas in which are involved physical activity, movement, physical education, body work, and dance, besides all kinds of sports. There is also a world of possibilities for the use of SP relating to disease prevention, health promotion, child and youth development, and community organization.

Conceptualizing Sport Psychology

For Thomas (1980), SP investigates the causes and effects of the psychological processes occurring before, during, and after a sports or leisure activity. For some, this concept limits

the field by not incorporating an overview of sports as a human dimension that can be studied in an expanded time frame. Machado (2006) understands that Thomas is not neglecting issues such as personality, aggressiveness, anxiety, goals, and motivation, and do not feel that the definition precludes looking at activities such as free time, leisure, and dance. Other authors such as Singer (1997) and Cratty (1991) suggest expanding this concept to a situational study of sports, looking not only at activities but at sets of situations involving sports. In this way they can embrace a variety of related issues including free time, dance, and the learning and practice of specific sport activities.

The question of studying the activities or the situations leads us to reflect that a concept may not be as needed as a clarification on what is the object of SP and how it must be methodologically approached. Our understanding is that the object is multifaceted and embodies both activities and whole situations related to the practice of sports. In this sense, scientific knowledge of psychology must be utilized in accordance to the specific issue in view. By the same token, scientific knowledge of the areas involved in the situation studied must be utilized according to the necessity of its particular use. If one is to study, for instance, the application of sports to preventive care in diabetes, the wholeness of situations involved in this particular issue will lead to the necessity of knowing about diabetes, preventive care, and also about the possible influence of various sports in the conditions usually presented to diabetic patients in their everyday life. The same rationale can orient the use of sports for youth at risk, school children, or institutionalized persons. The question becomes, what are the conditions present in everyday lives of such groups. A situational map (Clarke, 2005) can be drawn and such mapping can point to the knowledge needed and to the approaches to be taken.

The above proposal for a dynamic, contextualized conceptualization of SP does not preclude the fact that there are some basics to be covered. Sport science and SP, in their basic and ample view, as well as the social, political and economic historical contextualization of human life are givens. We cannot understand human activity or human situations without contextualizing them in the present historical conditions and without an understanding of the historical succession of events that brought us to where we are. The historicity of social relationships, to use a Freirean word (Freire, 1970) is a key to any understanding of human development. SP is a science of situations, activities, and behaviors, it is therefore a socially contextualized field of knowledge. Its conceptualization asks, therefore, for the social, political, economic, historical contextualization of its body of knowledge.

Sport psychology and competitive high performance sports

In the frantic world of high performance sports the burden put on the shoulders of athletes is always on the rise. They are always requested to break a new record, to surpass a limit, to exert their bodies, to deny their social and personal lives. They are always on the verge of a great victory or a terrible defeat. Their self-esteem is always prone to be inflated or lowered depending on the result of the game, be it a final in an Olympic Game or a high school basketball competition. The consequences of competition is an object of scrutiny for those who study and deal with high level athletes but is also present, and not always perceived, at all levels of human life.

Well known to high performance athletes is the influence of fans. Fans make of these athletes gods, in a certain moment, just to take them to martyrdom in the moment to follow. In its own proportions, athletes of all levels feel the pressure of fans, even in a very small scale. Expectations of performance can generate enormous anxiety and winning or losing can mean exactly that, being identified as winners or losers. Fans identify with their idols and transfer to them their own expectations, their own necessities to overcome frustrations and may not have the necessary sensibility to understand that these forms of displacement can influence athlete´s careers or their lives. We can see examples over and over, day after day, of this seemingly dramatic, but true, reality.

What should then be the role of competition in sports? Does competition contribute for the betterment of society, of athletes, or of human relationships? This question has been asked in SP (Cratty, 1998; Guay, 1997) but there are still rooms for more exploration. In attempting to design or to re- design a conceptual framework in SP we must take this question to the limit as it is central both as an issue pertaining to the essence of high level performance sports as well as to the general approach to human development. Nearly every person faces competition in practicing sports activities, be it in neighborhood playing, school games, or during recreation hours. Many have some ability in some sport and this may help them to build healthy personalities. Others suffer, as they do not have the necessary abilities or confidence and are not identified, sometimes, as desirable playing partners. Many times the unskilled, unconfident, rejected, suffer silently, often for long periods of time, adding to other psychological problems related to other situations of demonstrated lack of success and abilities, which prevent them from overcoming these very insufficiencies. As a result we may find on the one hand virtuous cycles of heightening self esteem and success, and vicious cycles of low self esteem and lack of success for those who did not have the benefit of some help in this area.

Re-building healthier communities: A strategic role of SP

This paper sustains that the practice of sports, the teaching of sports, and the mentality guiding those practices and teachings are key to child, adolescent, and human development. Therefore, the way we approach practicing sports, the pedagogy of sports, the psychological approaches to doing sports, and the philosophies behind the placement of sports in society are strategic to human development.

A corollary of that is that schools, universities, sport clubs, character development organizations, and health services have ethical responsibilities related to the practice and to the theoretical bases of their approaches to doing and teaching sports in society. The development of SP as a field of knowledge is absolutely needed if the society wants to deepen its understanding about the role and psychological impact of sports at the personal, interpersonal, community and societal levels. There is a need for more interdisciplinary studies, transnational collaboration, crossing professional borders aiming to disclose the intertwining of the many issues clearly or otherwise subtly involved in the practice and teaching of various forms of sports in different levels and dimensions. Not only the traditional studies about personality and motivation, but also innovative studies looking at contemporary issues such as the way children, youth, and families socially represent and construct imaginary relationships with sport idols and sport events, how they take into their own lives the teachings of sport philosophy, the ideas that constitute the paradigms orienting the practice of sports.

We also contend that sports constitute a major factor for the purpose of social and community development, besides personal and group identity formation. Therefore, communities have a great stake in understanding the psychological, philosophical, social, cultural, political, and economic issues involved in professional and recreational sport practices. Families have been popularly recognized as the mother cell of society, and communities are the collective of families, be it of a biological, traditional or otherwise basis. Community building is a major path that can lead to a harmonic social life, to a socially sustainable society, says Morin (1997), to which we totally agree.

In the 1970s and throughout the 21st century so far a new paradigm has been proposed in the context of the health sector, involving the concept of Health Promotion (HP). HP goes beyond the performance of healthy activities to a philosophical position before life, one that promotes choice and responsibility, as well the encompassing of rights, policies and state responsibility for the health of all citizens (US Department of Health, Education and Welfare, 1979). It calls for a deeper reflection on citizenry and the empowerment of individuals and communities, and it points also to the emergence of a true conscience about health in a deeper and extended form of comprehension

In the context of HP, sports cannot be reduced to one more commodity, one more area of market or another set of normative activities. It must reach the place of a human strategy for human development, fostering its own reconceptualization. Instead of doing as an end, HP calls sports to Being, Doing, and Becoming as a part of re-structuring paradigms, re-building community, and rethinking citizenry. Sport Psychology has to be in the center of this international effort for re-creating societies, a necessary part of the evolution of the Human Sciences, and for the construction of healthier and happier communities.

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Contemporary Issues in the Teaching of PE in Malaysia

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INTRODUCTION

In Malaysia, Physical Education (PE) is a compulsory subject taught in all primary and secondary schools. PE is considered important by the Ministry of Education in promoting the modern concept of education. This concept involves the development of the 'whole child' or a well-rounded child. It has been incorporated in the National Educational Policy where PE is part of the total school programme. The total school programme is designed to assure the optimum growth and development of school children through directed physical activities. Together with this modern concept, PE in Malaysia is also guided by The National Philosophy of Education which states that:

> Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious, based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards, and who are responsible and capable of achieving high levels of personal well-being as well as being able to contribute to the harmony and betterment of the family, the society, and the nation at large (Ministry of Education, 1999; Malaysia Education Blueprint, 2012)

PE is included in students' main daily timetables. It is allocated two forty-minute periods weekly for the secondary schools and two thirty-minute periods weekly for the primary schools. The PE programme's personnel includes all teachers whose option subject may be PE or other subjects.

THE STATUS OF PHYSICAL EDUCATION IN MALAYSIA

In the Malaysian school curriculum Physical Education (PE) is accepted as education of the physical through the physical. As it is a compulsory subject, it is seemingly accorded the same status as other subjects in the school curriculum and accepted as on par with other core subjects although PE is not an examination subject.

Even though PE is a non-examination subject, formal evaluation for various components is done at least twice yearly. This is done through 'School Based Evaluation' (Ministry of Education, 1997, 2011). Results are recorded in the students' progress report cards. The recent development in PE resulted in a new curriculum which has consequently given the subject a boost towards better standing in the implementation of the school curriculum. From 1999 onwards, tests for all physical fitness components will be carried out on every student and the results will be recorded.

On the contrary, deVries (1975) made the following observations: PE is a non-examination subject which is always considered least important when making important decisions affecting the subject (scheduling of PE classes, allotment of financial resources, assigning PE teachers). Decisions are made only after the other examination subjects have been considered;

a. Teachers who are qualified in PE are assigned to teach 'more important' or examination subjects;
b. Some schools have PE periods on paper but in reality, the administrators use PE periods for the 'more important' examination subjects.

In addition, de Vries (1990) noted that the Malaysian educational system and the Malaysian public do not understand and value the role of physical activity-exercise-sport in life and society. Thus, they give little value to PE. In addition, Abd. Rashid Salleh (1997) found an influence of different ethnic groups on the attitudes of PE. Cultural influences played a part in determining the value accorded to Physical Education and its status.

'Physical and Health Education is a non-examination subject given little regard in the scheme of things in an exam-oriented school culture. Often, its periods are used to teach subjects which are of more academic value,' (Frederick, 1998, Sunday Times, p.8). The scenario prompted the Malaysian Minister of Education, Dato' Najib Tun Razak (present prime minister) to comment : 'There is a need to change the notion among some school heads that Physical Education is less important than other subjects' (Frederick, 1998, p.7)

In a survey of secondary school students, The Star Newspaper (27 November, 2011) reported some observations which revealed current scenarios in school PE. Some students were positive about having PE lessons while others were not interested. Those students who were interested complain about the lack of time, regimented lessons, lack of physical activities except stretching, the loss of opportunity to de-stress before main examinations, and there were no proper changing rooms except toilet cubicles. They also stated that PE lessons were often replaced with other lessons and students were sometimes allowed to do what they wanted during PE lessons. While some students were not interested in the physical activities and playing in the field, they welcomed PE lessons as the time to catch up with friends; sitting and chit-chatting. In regards to the quality of PE teachers, it was observed that some teachers are qualified but the majority are not.

ISSUES IN TEACHING PE

When PE is accorded the same status as other subjects in the Malaysian school curriculum, it is to be construed that the same consideration be given in the management of PE programme by the school administrators. But the statistics in the past ten years revealed some concerns that require immediate short term and long term actions. The challenges may be categorized into three which include teacher related challenges, student related challenges and administrator related challenges. The issues in the teaching of PE will be examined according to those three categories.

PE teachers in Malaysian schools are a mixture of both PE majors and non-majors. Wee (2001), and Sebastian and Wee (2006) found that only 15.2% and 20.9% of secondary

school PE teachers were PE majors respectively. In addition, Wee, Khor and Jamatul (2004) found only 6.2% of primary school PE teachers were PE majors. As such, 'non-field' teaching appears to be a norm, inculcating not only inadequate teaching but non-teaching scenarios. The lack of qualified PE teachers have not been paid attention to since PE is considered expendable as reflected in the Sunday Times newspaper report: 'Physical and Health Education is a non-examination subject given little regard in the scheme of things in an exam-oriented school culture. Often, its periods are used to teach subjects which are more academic value' (Frederick, 1998, p.8). The situation has not changed since 1980s and 1990s. MOE (1994/95) reported 65.4% of PE teachers' performance as average or weak. Another report in 1982 (MOE, 1982) found that 62% female PE teachers lack knowledge and skills in football, sepak takraw (rattan ball), basketball and hockey. Despite schools having many non-optionists teaching PE, there was no PE and sport related courses organized for them (Chong, 2001; Husari Mohri, 2002 & Wee, 2006), resulting in the lack of pedagogical knowledge (Noreha Sarkawi & Juslimah Jani, 2006).

In the Secondary School Inspection Report [SSIR] (2007) involving 36 schools and 68 teachers in nine states (32.4% PE option, 67.6% non-PE option), it showed PE teachers' performance to be 56% at average level and 15% were weak. It was also found that 63.5% of the teachers surveyed could state objectives explicitly, only 48.5% non-option teachers could teach according to teaching progression [primary school, 49.2%], 42.6% could detect and correct students' weaknesses, 54.4% could provide feedback to students and only 42.7% did self-evaluation on their strength and weaknesses. The report revealed startling information that teachers taught sport skills not found in syllabus and teachers did not prepare PE lessons (SSIR 2008).

In addition, Sebastian and Wee (2006) [13 schools, 81 teachers] revealed that 42% (Strongly Agreed & Agreed [SA & A]) of the teachers surveyed agreed having knowledge to teach PE, 67% (SA&A) agreed they could manage class, 56% (SA&A) agreed they could teach game skills, 31% (SA&A) agreed they could detect students' weaknesses and 35% (SA&A) agreed they could correct students' weaknesses. Tan and Lee (Tan Siew Eng & Lee Fook Kwang, 2004) reported the inability of PE teachers to be creative in managing students and were also not capable of maximizing the usage of equipment during teaching. They reported that teachers often lined students in two lines of 20-30 students each operating with one ball, while there are a dozen or more equipment unused.
In the Primary Schools Inspection Report (2007) which involved 61 PE teachers from 46 schools in 11 states, it was found that PE teachers were 9.8% (n=6) PE option and 90.2% non-PE option. It was found that 67.2% of PE teacher's were of average performance and 16.4% were weak.

STUDENT RELATED CHALLENGES

The Primary Schools Inspection Report (2007) through the observation of 36 PE teaching classes reported that 59% of the students attended PE classes punctually and they tried hard during class activities. However, only 75.6% wore appropriate PE attire. In the Secondary Schools Inspection Report (2007) which included 36 schools and 68 classes, it was found that 50% of students wore proper attire. Boys were found to be more properly attired as compared to girls (SSIR, 2008). In a survey which surveyed 374 students and 270 PE teachers, Haslindah Nursan (2010) reported that 58.5% of the students did not believe their peers were lazy for not wearing proper attire during PE lessons even though 77.4% of

teachers believed it was so. The main reason may be the limited time for changing and the lack of proper changing rooms for students to change clothing for PE lessons.
Haslindah Nursan (2010) also reported on students' perceptions on PE attire and changing rooms; 76.2% felt they should be allowed to wear PE attire to school and 64.1% felt that they should be allowed to continue wearing PE attire after the PE class. The same report revealed the teachers perception on PE attire. It was reported that 77.4% of PE teachers felt that students were lazy to change, 60.7% felt they were influenced by peers and 80.4% students always had reasons for not wearing PE attire. Similar findings were revealed by other researchers that female students were not interested in PE and were afraid of heat as PE was outdoor (Chong Ai Ling & Norlena Salamuddin, 2010). Chong and Norlena also reiterated that students lack enthusiasm toward PE and were not interested to learn skills.

ADMINISTRATIVE RELATED CHALLENGES

a. Supervision/Monitoring of PE teaching
Observation & supervision of PE lessons by Principals did not take place (Tan Siew Eng & Lee Fook Kwang, 2004). Wee (2007) reported that only about 50.6% of principals 'frequently' and always' did so, 6% of the principals delegated the observation responsibilities to their assistants. In addition, there was no observation plan by the PE Curriculum Committee and teachers did not prepare their lessons (Wee, 2008).

The lack of supervision in PE was reported in the PSIR and SSIR (2007); only 18.5% (8 of 46 schools) carried out the mandatory s supervision at school level. As such only 49.2% primary teachers and 48.5% secondary school applied the progression principle (PSIR & SSIR, 2007). Of the 66.7% (of 36 secondary schools) who carried out the fitness test, 16.7% did analysis and reported the findings and only 5.6% had remedial measures for students.

b. PE classes are expendable
PE classes are expendable, as it is regularly used for the teaching of other more important subjects such as mathematics and science, especially when the public examination is around the corner. Chong Ai Ling and Norlela Salamuddin (2010) revealed that when exams are approaching, PE classes are used for other subjects and to complete the syllabus of these subjects. New timetables were put in place. PE teachers could not do anything about this and merely followed instructions. This was earlier reported by Wee (2009) that 73.7% of principals 'always' allowed PE classes to be used to teach other subjects.

c. Staff Training Program (STP)
In Malaysia, the Ministry of Education requirements (MOE, 1998) specified that school principals must plan, administer and evaluate school STP. School heads must identify the strengths and weaknesses of the teaching staff and plan staff development programmes based on the identified needs. In addition, they must also monitor and take appropriate corrective action to change the STP to ensure its effectiveness. The status of STP was reported by Sebastian and Wee (2006), where 30.8% of schools never organized STP, 62.9% organized 1-3 times annually. MOE (2007) reported 29.4% secondary school organized STP. Similarly, Wee (2009) reported that only 14% of the principals in 290 secondary schools organized in-house training programmes.
In order to overcome this problem, MOE has embarked on a new 6-week pilot Intervention Training Program for Extra Option Secondary School Teachers (Pito). This program has started in December 2011 at several public universities, targeted the Science and

Mathematics teachers nationwide. The teachers selected for the program will choose History, PE or Geography as their second option subject. However, it is still unclear if teachers would choose the PE subject as their second option subject.

Lack of Facilities and Equipment

The problem of the lack of facilities and equipment was reported by Chong Ai Ling and Norlela Salamuddin (2010). Most schools surveyed lacked equipment and spoilt equipment were not repaired or replaced. They drew the attention to the issue of too many students using the outdoor facilities at the same time. The lack of indoor facilities in schools and the weather conditions forced PE lessons to be conducted between 7.30 am to 10.00 am. The heat will be unbearable to have PE lessons outdoors after 10.00 am.

An earlier report by MOE (1982) found that out of 24 schools in Klang, Selangor, 50% of the school fields were small and unkempt. In addition, 70% of the schools lacked basic equipment for gymnastics and athletics and 40% of the schools lacked game facilities. Another report by MOE 1994/95 (118 schools in 7 states in Peninsular Malaysia) revealed that financial allocations in schools were not properly planned for the procurement of equipment.

Wee (2001) surveyed about 300 schools and found that schools often have a soccer field (77.2%), netball court (75.7%), volleyball court (71.6%), sepak takraw court (69.8%) & badminton court (56.7%). In another study, Sebastian and Wee (2006) studied 13 schools and found that 92.3% has a soccer field, 76.9% has a netball court, 61.5% has a volleyball court, 69.3% has 1-2 badminton courts, and 61.5% has a hockey field.

Secondary school students were not interested in PE, especially girls. They were afraid of heat and often say that they are tired. In addition, students lack enthusiasm toward PE which may be due to a lack of skills but even so, they are not interested to learn skills (Chong Ai Ling & Norlena Salamuddin, 2010).

CONCLUSION

Research findings revealed flaws in the implementation of PE and in the monitoring of teaching and learning of PE in Malaysia. PE has been side-lined by a majority of the schools in various aspects. As such, there is a strong need to create awareness among students, teachers, administrators and parents about the importance of PE.

It is expected that MOE will conduct more PE in-house and special courses to help train the non-option PE teachers as well as teachers whose performances are not satisfactory. The emergence of a 6-week pilot Intervention Training Programme for Extra Option Secondary School Teachers (Pito), started in December 2011 at several public universities provided some hope for PE if teachers involved are required to enroll in PE.

This seems like a step in the right direction but more effective monitoring systems are also needed to ensure the proper implementation of PE programmes in Malaysian schools. The administration and the implementation of PE at school level currently depend very much on the vision of the head of school. However, various parties should work together to advocate a proper PE system for the students of Malaysia.

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Health Related Fitness Promotion: An Experience from Romania

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Abstract

Sports science, through sports medicine and exercise physiology as its components and basic support, responds to the needs of conceptual and methodological foundation of movement and its enhancement as an indispensable element for a good health and equivalent of the quality of life in different pathologies. Exercise physiology represents the basic physiological support for restoring the functional capacity of individuals and for physical health assessment. The positive effects of physical exercises on metabolic, cardio-respiratory, endocrine, hematological and nervous systems (improved functions and decreased fatigue, anxiety and depression) bring the focus on using exercising as part of basic preventive mean with high effectiveness and low costs.

INTRODUCTION

Sports science, through sports medicine and exercise physiology as its components and basic support, responds to the needs of conceptual and methodological foundation of movement and its enhancement as an indispensable element for a good health and equivalent of the quality of life in different pathologies (McArdle et al., 1996).

Exercise physiology studies not only the effects of movement on body functioning, but also all of physiological adaptations in a multifactorial context (social, economical, political and cultural). It represents the basic physiological support for restoring the functional capacity of individuals and for physical health assessment(Georgescu, 2002; Ciucurel, 2005).

The interested target groups are characterized by a large diversity: healthy people, sedentary, disabled people, elderly and individuals with various metabolic and oncological pathologies. In this context, objectives like life span, life expectancy, life satisfaction and improvements of health status are the most pursued within different interventions.

Because of the ageing of population in the context of low birth rates the current concerns are focused to reduce the risk of diseases and to increase life expectancy and quality of life. Among the current priority directions promoted in Romania we must highlight the efforts for reducing the rate of obesity, the elderly care and assistance programs and the prophylaxis of oncological diseases (Ciucurel et al., 2008).

According to recent studies of the Romanian Federation of Diabetes, Nutrition and Metabolic Diseases, 50% of Romanians are overweight and the obesity rate increased at 25%. The interdisciplinary approach of the problems associated with excess weight is very important and we esteem that by integrating therapeutic education programs, focused on

awareness of the beneficial effects of physical exercises on overall health and particularly on the morpho-functional parameters, it can be increased the efficiency of prophylactic and therapeutic measures (Tudor et al., 2010). Regarding the assistance for aging population, it is notable of the Romanian Ministry of Health decision to convert a large number of local hospitals into retirement homes and centers for the rehabilitation and recovery of elderly.

PHYSIOLOGICAL SUPPORT

The positive effects of physical exercises on metabolic, cardio-respiratory, endocrine, hematological and nervous systems (improved functions and decreased fatigue, anxiety and depression) bring the focus on using exercising as part of basic preventive mean with high effectiveness and low costs (Dragan, 2002; Laure, 2007).

The training programs involves selecting exercises with functional effects, the sequence of exercises, number of sets, timing and intensity and the practical models of training are built by setting general objectives and specific goals.

Starting from the different testing procedures (based on energy consumption, cardio respiratory and biochemical parameters) of physical exercises' effects on body functioning we propose the model of a mobile team responsible with the screening of the population's fitness level, therapeutic education, awareness individuals on their functional level through self-evaluation and the evaluation of people's wellbeing and stress level (Georgescu, 2006).

CONNECTION BETWEEN HEALTH, QUALITY OF LIFE AND WELLNESS

The quality of life comprises economical, political aspects related to the health status and the relation to the geographical, social environment. The approach of the quality of life regardless of the analysis perspective brings wellbeing to the spotlight. The wellbeing, in its turn, is in a close connection to education, the manner in which free time is spent, the class membership, the subjective manner of perceiving things that bring us joy and happiness (Plivares et al., 2011).

From the point of view of evaluating the wellbeing, there are two aspects: the wellbeing of the individual and the manner of promoting/improving/keeping it. By some studies and researches, the most frequent associations that lead to defining the quality of life are: the health status; absence of disease, invalidity; paid leave - rest - recreation - free time - leisure activities - repose; emotional states as joy, affection, happiness, lack of sadness, anger and stress.

Other important parameters for defining the quality of life, but having a pluricausal feature are: family life, life in the community as well as natural, financial aspects, political stability, safety, geographical environment and climate-related factors, safety given by having a job, freedom of speech, gender equality, non discrimination by racial, religious criteria or sexual orientation.

According to an international study, Romania is on the 58th place in terms of quality of life. The indicators used to assess the quality of life, regarding healthcare are summarized as: being – belonging – becoming (3B) – which refer to: acute injuries that are not life-

endangering and chronic injuries that are not life-threatening and are not in terminal stages (Costanza et al., 2008).

RELATIONSHIP BETWEEN HEALTH AND TOURISM

Currently, Romania is on the 5th place in Europe in terms of the balneary potential, occupying the last place in terms of addressability and harnessing the climate factors of spa treatment associated with geographical factors.

At present the place of balneary treatment is taken by medical treatment, which associates the specialized treatment at lower prices than in the West; it interlocks with the activities of spending the free time in a pleasant manner, agreeably in tourism packages which combine as well the benefits related to the geographical environment, cultural traditions, culinary habits and especially ecological habits.

MODERN TRENDS IN PREVENTIVE HEALTH

A new challenge of the contemporary world is the tourism for health and wellbeing that combines free time activities spend in a different geographical and cultural context and it contributes to the improvement of wellbeing and of the quality of life.

Romania's alignment to these new tendencies supposes a modification of the strategies and means of promotion of the local/regional/national health tourism potential, along with a policy of attracting potential customers. To this sense, among the development of the infrastructure, is also necessary the development of constructions and arrangements by the effort of the local, regional, governmental/non governmental communities (Georgescu, 2011).

An important place is held by training specialists for this sector, which thus becomes more and more attractive and important to the economic development of certain regions.

The existent specialists who can work within this sector are physicians, physiotherapists, medical nurses, masseurs, the Romanian occupational code (COR) offering a few occupations that may tangentially serve or contribute to these purposes.

The starting point for the development of a project of the Life Long Learning type, promoted by the University of Pitesti, in collaboration with partners from three European countries, was the lack of an occupation destined exclusively to this sector. The elements that are at the basis of building occupational standards for this new qualification were identified as being part of tourism, ecology, management, nursing, health (elements of massage, reflex therapy, complementary therapies and elements of physical therapy and palliative care) (European Commission, 2011).

Prophylaxis in physical therapy means the application of aerobic exercises on the principles of the science of medical training and it applies to:

- healthy persons in order to prevent them from diseases or the emergence of the physical deconditioning syndrome (1st degree prophylaxis);
- elderly persons to whom deconditioning appeared for preventing them from its decline and extension (1st and 2nd degree prophylaxis);

- ill persons (suffering from chronic diseases) for preventing them from getting worse or from complications of these diseases (2nd degree prophylaxis). Due to the fact that this notion interferes with the one of recovery and physical therapy, The World Health Organization calls it the 3rd degree of prophylaxis (Sbenghe, 2002).

The purpose is represented by transparency and flexibility in occupying a workplace in the sector destined for tourism for health, creating certain alternative solutions of workplaces on the labour market in the European Union. The prophylaxis spa treatments of the health status come back to attention and become an important source for the development of certain local communities. We have selected experienced partners with long tradition in promoting tourism services, but also being experienced in the educational sphere of training specialists destined to this sector, which is very attractive and "trendy": Austria, Bulgaria and Greece.

The Greek partner additionally ensures the inclusion of the IT system in the modernization of the teaching techniques in the vocational system. The vulnerable target-groups are:

- the unemployed people, persons who change qualification, professional retraining, persons having deficiencies;
- students for obtaining a qualification that would ensure an income during university years.

Tourism for prophylactic purpose knows a degree of ampleness in a real conjuncture of the evolution of morbidity at an international level, the preoccupations of the international organizations and of the governmental/non governmental ones being centred mainly on promoting and developing the local/regional tourism potential and training certain larger categories of population in this economic sector more and more important and interesting, but also profitable at the same time.

Balneary, medical tourism has known an important development of knowledge, an important development; nowadays it is advanced by the therapy having a recreational/ loisir feature, many activities being combined with local, geographical, climate, cultural, nutritional factors.

The absence of pollution, of stress, associated with a pleasant and varied scenery helps reaching the wellbeing status and cultivating certain feelings of joy and happiness, pleasure with relaxing and recreative effect at the same time. A special attention is held by the educational system in training specialists and promoting the beneficial aspects of the therapy having a recreative prophylactic type. The diversification of the services includes promoting certain traditions, of sports activities having a specific feature or even the emergence and the tendency to promote certain new activities (Edginton et al., 2011).

In this manner, the applicability of the principles of recovery of certain population categories with individual diversity and variability: gender, race, and pathology, physical, psychical vulnerability, disabilities surpasses the psycho- physiological barriers and determines spectacular improvements.

The quality of life and wellbeing relates to all educational system, subjective and objective, most of the modifications/ adaptations leading, in the end, to a visible perfecting from a morphological point of view.

Specific to the current stage is the interdisciplinary and multidisciplinary in approaching certain complex phenomena, the wellbeing and the quality of life being clear examples of these tendencies. The current strategies used in promoting health, quality of life and wellness determines associations or interrelations to biology, psychology, medicine, exercise, chemistry, physics, geography. This generous context is an endless source of promoting/identifying/optimizing directions for research having a practical applicability in a humanitarian and social purpose.

A lot of modifications draw attention and it concentrates around the individual is the source for the development of society for present and even future times. The prediction of short-term, average and long-term speed and evolution of the contemporary world has at its basis all these aspects and the effort of the specialists converge toward a better life from all points of view.

Promotion and integration of physical exercises as means of maintaining people's wellbeing is a challenge for the contemporary world in the context of more and more diversified epidemiology of the chronic medical conditions.

It is important for government decision makers, community authorities, primary prevention systems, but also for educational system at all levels to get involve in physical activities promotion by synergistic and convergent actions.

CONCLUSION

Regarding the strategies to promote wellbeing, health and quality of life it is important to point a few: development of multi-disciplinary partnerships, focus on social responsibility for maintaining and achieving the required health standards, diversification of community services and the provision of necessary means for their implementation.

In a highly interconnected and interactive world, the strategic objectives for integrating leisure, sport and wellness in cities and communities should aim: the engagement of active people in physical activities; increasing and maintaining a proper fitness level among people; motivation, encouragement, competencies development, collaboration and secure means for achieving these objectives.

ACKNOWLEDGMENTS

Acknowledgments to LEONARDO da VINCI, Transfer of Innovation, "e-Training for wellness in spa services /eTRAWELSPA", LLP-LdV-ToI-2011-RO-022, 2011-2013.

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Coach Development Program: 'Where are we going?'

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Abstract

Nippon Sport Science University launched a new master's degree program on coaching in 2011. The basic philosophy underpinning the entire program is 'athlete-centred coaching'. Three competences we believe coaches should consider are planning, leadership, and reflection. The uniqueness of our program is putting the emphasis on practicums. To facilitate students' learning, an academic supervisor and a master coach cooperate in the program. We tried three different learning opportunities, i.e., formal, nonformal, and informal learning, together in our program. One of the strengths this program has is the fact that many coaches from different areas are learning together. Each coach has different personal trait and working contexts. By sharing information among coaches, they will learn or rehearse in advance to solve problems they might encounter in monthly held coaching conferences. Master's thesis is mandatory in this program. There are two options for the graduate students. One is a thesis as a researcher on coaching and the other is a thesis as a coach. The sporting or coaching field is a laboratory for coaches. Coaches are facing very unique situations every time and it is almost impossible to separate one feature from the whole to fix the problem. Another consideration on research paradigm would be 'from WHAT to HOW'. Knowing WHAT is not enough when you actually coach athletes. It is important whether you can put that knowledge into practice. That is HOW and the art of coaching. Action Research would be the one solution for coaches to develop their coaching expertise both practically and academically. Ethnographic research is another option. A qualitative research approach is also considered worthy of attention. The most important thing in conducting a research on coaching is a research question. For the most of the graduate students in our coach development program, main research interest would be how they can improve their coaching practices. We believe that by conducting researches on effective coaching will enable better coach education or development as well as effective coaching practices. This will raise the value of sport, and finally leads to higher quality of life.

Nippon Sport Science University (NSSU), formerly Nippon College of Physical Education, was established in 1893. NSSU is well known as Nittaidai in Japan. NSSU reformed the structure of the graduate school of health and sport science in 2011 to launch a practical

master's degree program for coaches. In this article, we introduce the endeavour of the NSSU graduate school to share information on coach development in higher education.

BACKGROUND

After school sport club activities have contributed to the development of sports in Japan. Some sports such as swimming, tennis and golf, are based outside school and in commercial clubs. Soccer is unique because since the establishment of J-League, Japan Professional Football League, in 1993, players have been training either in clubs or at school. Most of the coaches in after school sport clubs are teachers. For this reason, a student who wants to become a coach tended to choose becoming a teacher.

As of December 2010, in Japan, there were 163 universities which have a sport-related department. Among them, 146 universities or faculties offered PE teacher licenses for junior high and high schools. NSSU is one of those universities. The students are learning in one of four departments, i.e., Department of Physical Education, Department of Health Science, Department of Martial Arts, Department of Lifelong Sports and Recreation. NSSU has been also putting much effort on developing high performance athletes. The students and alumni have earned 108 Olympic medals (33 gold, 34 silver and 41 bronze medals) before London 2012 Olympic Games and 9 medals have just been added to the NSSU medal table in London. Based on the freshmen survey conducted in 2010, approximately the quarter of the freshmen reported that they wanted to compete in international levels. In the same survey, 93% and 88% of male and female students, respectively, answered that they were interested in becoming coaches in the future. Interestingly approximately 90% of the freshmen answered that they wanted to obtain PE teacher licenses but 30% answered that they would get national certified coach certificates. The low percentage of needs for coaching certifications might be due to the lack of the freshmen's knowledge about the national coach certification scheme. If they knew that they needed to be a certified coach to coach representative teams for national championships, these results might have been different.

Many athletes became coaches soon after finishing their careers as athletes. 'Can play' does not necessarily mean 'can coach'. Abilities needed for sporting success as an athlete are different from those of a coach needed for effective coaching. Coaches should operate professionally and with integrity in their relationships with those who are participating in, or associated with, their sport (Australian Sports Commission, 2006). What is considered to be successful coaching is dependent on how we develop our own skills and behaviours to meet athletes' needs (Kidman & Hanrahan, 2011). As a pioneer of sports coaching in Japan, NSSU decided to create a new master's degree program suitable for developing super-coachers who can take a leading role in sporting communities.

UNDERPINNING CONCEPT AND COMPETENCES

The basic philosophy underpinning the entire program is 'athlete-centred coaching'. You could often hear that if you focus on building athletes' good characters, the possibility of winning have to be compromised. A lot of coaches put their priorities thoroughly or rather on winning, which lead them to make athletes obey to coaches' commands. On the other hand, recent literatures convey the ideas of guided discovery and problem solving, such as TGfU (Butler & Griffin, 2010), Game Sense (Light, 2006; 2013), Play Practice (Launder & Piltz, 2006). These approaches are mainly based on constructivism and put leaners or athletes right in the middle of interest. We have adopted the athlete-centred coaching as the more humanistic and thus acceptable approach (Kidman & Lombardo, 2010; Kidman & Hanrahan, 2011). Three competences we believe coaches should consider are also declared, i.e., planning, leadership, and reflection. Planning includes a variety of issues such as understanding the long-term athlete development concept, periodization, tapering, peaking, etc. Leadership deals with how coaches act. Reflection includes monitoring own practices, discussing with others on the practices, and behaviour modification. All the modules are delivered with these philosophy and competences in mind.

The uniqueness of our program is putting the emphasis on practicums. Graduate students can work in actual coaching contexts throughout the two years program. Recent papers have postulated the importance of workplace learning (Rynne et al., 2006; Rynne et al., 2010). Lombardo & Eichinger (1996) reported that people learn their skills mainly from on-the-job experiences, tasks, and problem solving and relatively less from formal courses and reading. Coaching education programs around the world have traditionally focused their attention on the development of professional knowledge (Côté & Gilbert. 2009). Coach education or development programs delivered in higher education levels are mainly focusing on knowledge of sports sciences and conducting researches on biomechanics, physiology or psychology in regard to sport performance. Coach education programs should include supervised field experiences throughout, possibly in a variety of contexts, to enable coaches to consider differences, make mistakes, reflect and learn from them and try again (Cushion et al., 2003). Coaches as practitioners are also thought to learn from the experiences during their coaching practices. However, to become better skilled at one's professional practice, a novice teacher or coach needs to do more than simply spend time on the job. Ten years of coaching without reflection is simply one year of coaching repeated ten times (Gilbert & Trudel, 2006). To facilitate students' learning, an academic supervisor and a master coach cooperate in the program.

We tried three different learning opportunities, i.e., formal, nonformal, and informal learning (Mallet et al., 2009), together in our program. As formal learning opportunities, the program offers normal classroom sessions or activities such modules as research methods in coaching, coaching philosophy, skill acquisition, training and conditioning, sport sciences,

performance analysis and so on. As nonformal learning opportunities, the graduate school organizes a coaching conference once a month to share information with others and to learn from the others' experiences. For informal learning opportunities, graduate students go to coaching field and have chats with peer coaches and supervisors in a relaxed manner. It may be wrong to call these opportunities as nonformal and informal, because these have been prepared in the formal program. The important point, however, is that our program provides these three learning opportunities so that the learning of graduate students would be facilitated in the way to network the knowledge and experience not just accumulate the knowledge (Werthner & Trudel, 2006).

LEARNING FROM EXPERIENCES OF OTHERS

One of the program's strengths is the fact that many coaches from different areas are learning together. Each coach has different personal trait and working contexts. However when talking together, they can realize that they are facing or have faced the same kinds of problems. The world is changing so fast nowadays and coaches' jobs are diverse. By sharing information among coaches, they will learn or rehearse in advance to solve problems they might encounter. We hold coaching conferences monthly. They learn from each other and get broader perspectives. Typical program is as follows,

1. Current research topics in coaching
2. Practicum reports from graduate students
3. Round table discussion with a master coach

In the round table discussion, a master coach of our university presents topics of interest. A question and answer session with an experienced coach is a great opportunity for all the participants, i.e., not only for graduate students but also for their supervisors.

RESEARCH PARADIGM SHIFT

Master's thesis is mandatory to finish this program. There was a huge discussion over this issue when developing the program, because it could be so tough to write master's thesis while coaching in their fields. Some of universities worldwide offer master of art or master of coaching, which may not have to submit thesis at the end of the program. We believe that graduate students can learn more deeply by writing master's thesis on their coaching experiences. Then the problem would be what kinds of researches they should conduct. There are two options for the graduate students. One is a thesis as a researcher on coaching and the other is a thesis as a coach. The thesis as a researcher would be more like traditional researches used in biomechanics, physiology, and psychology. The thesis as a coach should be based on his or her own practices in the field. Coaches continuously encounter some kinds of problem to be solved in a daily context, and they figure out the possible solutions and put that into action. Coaches hypothesize what will be the outcome of their acts (or no

action), and they make decisions what they do to solve the problem. This is like a series of research projects that a normal researcher does in a laboratory. The sporting or coaching field is a laboratory for coaches. Coaching is the process, which is so complex and dynamic in nature. Coaching process is always dependent on the coaching context. Traditional empirical researches such as biomechanical or physiological researches control the surrounding conditions in order to make sure that the clear-cut result will be obtained. Those researchers use statistical procedures to show the reliability and validity of their findings. However, statistical significance would sometimes be of no use in coaching. Coaches are facing very unique situations every time and it is almost impossible to separate one feature from the whole to fix the problem. Davids, Button, & Bennet (2008) claimed that a systems perspective provides an excellent rationale for studying human behaviour. This is because structures and configurations of things should be considered as a whole, rather than examined piece by piece. In a highly complex system like the human mind or human body all the parts affect each other in an intricate way, and studying them individually often disrupts their usual interactions so much that an isolated unit may behave quite differently from the way that it would behave in its normal context (Davids, Button & Bennet, 2008; Clarke & Crossland, 1985).

Another consideration on research paradigm would be 'from WHAT to HOW'. Knowing WHAT is not enough when you actually coach athletes. It is important whether you can put that knowledge into practice. That is HOW and the art of coaching. The number of research papers on coaching increased dramatically from 1970's to 1990's (Gilbert & Trudel, 2004). Unfortunately, however, few studies which dealt with HOW have been conducted so far. We as researchers in coaching studies should go one step further forward to do researches as application science (personal communication with Lyle, 2012). How to use knowledge obtained in sports science and coaching practice itself should be our research area.

POSSIBLE RESEARCH OPTIONS FOR GRADUATE STUDENTS

Action Research would be the one solution for coaches to develop their coaching expertise both practically and academically. Kidman & Carlson (1998) published a research article about the modification of coaching behaviours in five coaches from different sports using action research. Barker-Ruchti (2002) reported on her experiences using action research as the coach of 12 gymnasts aged between 8 and 15 years. As stated earlier, self-monitoring and reflection is a key component to developing and improving coaching practices (Gilbert & Trudel, 2001; Kidman, 2010; Tan, 1997; Schempp, 2006). Action Research is "a form of collective self-reflective enquiry" (Kemmis & McTaggart, 1988) and has two major goals, i.e., to increase one's understanding of his or her professional practice and to use this understanding to improve the quality of that practice (Ahlberg, Mallett & Tinning, 2008; Kemmis & McTaggart, 1988). Action research is a self-reflective process that is cyclical in that graduate students move through stages including planning, acting, observing and

reflecting, then re-planning, further acting, observing and reflecting in order to improve their practices (Ahlberg, Mallett & Tinning, 2008). This is very important procedure and basically fit to the competences set in the program. As a coaching practitioner, graduate students can be expected to learn how to improve their coaching process through action research. Action research is collaborative in nature such that it involves input from several sources to best identify and plan behaviour modification (Ahlberg, Mallett & Tinning, 2008; Kemmis & McTaggart, 1988). Evans & Light (2008) conducted collaborative action research with a rugby coach. They concluded that it might offer a useful means of self-directed coach development in which academics in coach education could make a valuable contribution toward both coach development and the grounding of research in the day-to-day practices of coaches. By collaborating with other people such as an academic supervisor, a master or mentor coach, and critical friends or peer coaches, graduate students' learning would be facilitated because these significant others can give valuable inputs which cannot be identified by the students themselves. Furthermore by experiencing the action research process, graduate students are expected to continuously try to develop their professional skills after finishing the program.

Ethnographic research is another option. Essentially, an ethnography involves the in-depth study of a group through immersion into the culture of that group, often for an extended period of time, using multiple methods of data collection. The aim is to understand the behaviour or culture of that group by seeing it through the perspective of members of the group themselves. This involves the researcher becoming part of the group under investigation. Data collection is much more flexible, and data is collected as and when appropriate from available sources (Gratton & Jones, 2010). Graduate students are training their practices in their own coaching contexts. They have to understand or even create the behaviours or cultures of the groups. Field notes, video footages, voice recordings and other data can be used in this type of research.

A qualitative research approach is also considered worthy of attention. This does not mean that a quantitative approach is not suitable for coaching researches. Coaching involves at least two people, a person who coach and a person who are coached (athlete). Coaching deals with humans not robots. The relationship between a coach and an athlete are dynamic and complex in nature. Positivists assume that behaviours can be observed and objectively measured and analyzed. (Gratton & Jones, 2010). However, a lot of phenomena occur in a coaching context cannot often be measured. For example, meanings or qualities such as feelings, thoughts, experiences and so on, are not quantifiable. Qualitative research uses non-numerical data – often collected over an extended time period – and analysis to describe and understand concepts (Gratton & Jones, 2010).

The most important thing in conducting a research on coaching is a research question. For the most of the graduate students in our coach development program, main research interest

would be how they can improve their coaching practices. Each student has come to the program with different backgrounds and abilities, which lead to a different target to improve. They need to set a proper research question and always keep that in mind. Otherwise, they will get lost because of the complex and dynamic nature of their working field.

CHALLENGES AND FUTURE VISIONS

Our endeavour has just started with 11 and 12 graduate students in 2011 and 2012 cohorts, respectively. Individualization of learning for each student is one of the challenges we are facing. Each student brings different issues in at the same time. Their personal traits and backgrounds such as academic, cultural and sporting backgrounds differ remarkably from person to person. Some of the students have a physical education background and some do not. For example, it is often difficult to explain biomechanical rationale behind the scene of interest during discussion meetings, because some might have almost no experience of learning mechanics at school.

Communication and cooperation between an academic supervisor and a master coach are sometimes not sufficient enough because of their heavy daily duties. As a result, the qualities of practicum are quite diverse among graduate students. The assessment system of learning has to be improved as well.

Continuous professional development is another concern. The 2011 cohorts will finish the program at the end of March 2013. The two years of training as a coach in the program would be just the beginning of their life-long pursuit towards better coaching practices. It would be difficult to find an effective way to continuously develop their professional skills after finishing the program. Establishment of Coach Community for these coaches is expected.

Now we are restructuring our coach development program in the graduate school level. Next step would be establishing the connection between the undergraduate and graduate programs, which will enable 6 years of coach training. For example, video recordings during action researches or practicum in the graduate school can be used to facilitate the understanding of coach learning in undergraduate students. Providing learning opportunities for coaches who are already working would be important as well. As a leading university for sports, NSSU would be responsible for setting up continuous professional development (CPD) programs. Summer short programs or online programs would be possible options worth being considered.

We believe that by conducting researches on effective coaching will enable better coach education or development as well as effective coaching practices. This will raise the value of sport, and finally leads to higher quality of life.

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Assessment of Muscle Strength and Power in Sport and Clinical Settings

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Abstract

Physical performance tests have been used to assess muscle function, provide normative values for various groups of subjects, evaluate the success of training and rehabilitation procedures, prevent injuries, and evaluate the performance capabilities for sport- and work related activities. Simplicity, reliability and validity have made physical performance tests popular in areas such as sports medicine, athletics, physical education, physical medicine and rehabilitation, and ergonomics. Muscle strength and power has been considered as important physical abilities, particularly responsible either for maximum force that the particular muscle can exert in various functional tasks or for success of rapid movements (e.g., jumping, sprinting, throwing and kicking). A number of methods have been developed to estimate the force and power-generating capacity of human skeletal muscle. The most often applied strength tests are based on the maximal isometric, isokinetic or isotonic contractions against the controlled external loads, while the assessment of muscle power has been based on measurements of externally exerted muscle force and velocity, or work done during complex movements, such as cycling (e.g.,Wingate test), running. Among the factors that could confound results of muscle strength and power tests body size has proven to be an important one. Therefore, appropriate normalization for body size in routine tests of muscle strength and power should be applied. Having in mind the above mentioned importance of muscle and power assessment, the aim of this article is to describe the most often applied test of muscle strength and power, highlight some latest concepts in research and practice of strength and power assessment.

INTRODUCTION

Muscular strength and power are important characteristics of human exercise performance, particularly responsible for successful performing of various functional movements (e.g., jumping, sprinting, throwing, kicking…). Therefore, it isn't surprising why their assessment has an important place in a number of both clinical and non-clinical human movement related areas: Tests of muscular strength and power have been applied in order to assess muscle function, to provide normative values for various groups of subjects, to predict performance in relevant functional movement tasks, to evaluate the success of training and rehabilitation procedures, to prevent injuries, or to evaluate performance capabilities for sport- and work related activities. Having in mind the aforementioned importance of muscle and power assessment, the aim of this article is to shortly describe the most often applied test of muscle strength and power and to present some recent findings regarding this topic,

obtained in The Research Center of Faculty of Sport and Physical Education, University of Belgrade.

DEFINITIONS AND METHODS OF ASSESSMENT

Strength could be defined as a force [in Newtons (N)] or peak torque [Newton-meters (Nm)] developed during maximal voluntary contraction under a given set of conditions, while power [in Watts (W)] is the rate at which mechanical work is performed under a given set of conditions (Abernethy, Wilson et al. 1995; Wilson and Murphy 1996; Mirkov, Nedeljkovic et al. 2004) .

Strength is usually assessed measuring force or moment of force achieved during maximal voluntary contraction against the external resistance, under isometric, isokinetic or isoinertial conditions (Knezevic & Mirkov, 2011). The external resistance could be defined using isokinetic dynamometers, weight-training machines or other, custom built devices. Strength assessment could be performed either bilaterally or unilaterally (testing both legs simultaneously or each leg separately), in closed or open kinetic chain movements. Bilateral strength assessment is rarely applied in monitoring rehabilitation, because in such case the information regarding the strength of isolated muscle of the single leg is needed.

Closed kinetic chain (CKC) movements are those in which the distal segment of the limb is in contact with a support surface. These movements are typically weight bearing movements and the motion in one joint simultaneously produces motion in other joints of the limb (e.g., squats and jumps) in a predictable fashion (Pua, Bryant, Steele, Newton, & Wrigley, 2008). In recent years, the importance of using CKC in muscle strength assessment and particularly in rehabilitation (Beynnon, Johnson, Abate, Fleming, & Nichols, 2005; Dubljanin-Raspopovic, Kadija, Mirkov, & Bumbasirevic, 2011) has been stressed out, due to the belief that closed as opposed to open kinetic chain movements have more functional nature. Open kinetic chain movements (OKC) are single-joint movements (e.g., seated knee extension or flexion) in which the distal segment is free to move. These are non-weight bearing movements, and unlike the close kinetic chain movements, the OKC pose the ability to isolate the muscle of interest and allows a clinician to localize and quantify specific muscle deficits (Pua, et al., 2008). However, functional weight bearing movements will always involve motion in adjacent joints as well as the target joint, and strength assessed is such manner will reflect multilevel performance. It is, therefore, only the OKC feature that enables specific quantification of strength deficits in isolated muscles, and therefore only methods for strength assessment which utilizes unilateral open kinetic chain movements will be further discussed (Eitzen, et al., 2010; Micheo, et al., 2010; Pua, et al., 2008)

Based on the contraction type involved, strength assessment methods are classified to isokinetic, isometric or isoinertial dynamometry, whereas decision which type of dynamometry should be employed depends on the variety of factors (e.g., available equipment, time lapsed from the ACL reconstruction, similarity of testing outcomes and athletic performance, sensitivity of test measures to the effect of rehabilitation etc.).

Isokinetic Strength Assessment

Over the decades isokinetic dynamometry has become the preferred method for quadriceps and hamstrings muscle strength evaluation both in healthy individuals and in patients after ACL injury (Dvir, 1995; Eitzen, et al., 2010; Pua, et al., 2008; Zemach, Almoznino, Barak, & Dvir, 2009). Isokinetic assessment involves measurement of muscular force while the limb is moving at a constant angular velocity, where significant variability exists in the strength testing protocols applied in the studies reviewed, particularly regarding the angular velocities and number of repetitions used.

Isokinetic dynamometry measures could be obtained from 3 types of muscular contractions – isometric, isokinetic concentric and eccentric, and isoinertial. While the angular velocity of 0 °/s corresponds to isometric contraction, isokinetic contractions could be assessed throughout the range of angular velocities that could be up to 250 °/s or even 500 °/s, depending on the manufacturer. Although isokinetic dynamometry is widely used, their shortcomings have been well recognized in the literature. The main arguments are related to the absence of stretch-shortening cycle and that single-joint, isolated assessment bears little resemblance to functional performance (Pigozzi, Giombini, & Macaluso, 2012; Pua, et al., 2008). In addition, the similarity of isokinetic movements with everyday activities is questionable, since individuals have to work against a constant velocity (about 400 °/s) which is too low with respect to the maximum that can be achieved during "unloaded" movements of human limbs rather than a constant mass.

Isometric Strength Assessment

While isokinetic tests have been routinely conducted using isokinetic dynamometers (Pua, et al., 2008), the isometric strength test has been conducted using either an isokinetic dynamometer or a strain gauge force transducers attached to a custom build equipment (Suzovic, Nedeljkovic, Pazin, Planic, & Jaric, 2008; Wilson & Murphy, 1996). It has been well known that the outcome of isometric tests is dependent on level of familiarization, type of instruction given, muscular pretension and the joint angle selected for the strength assessment (Abernethy, Wilson, & Logan, 1995; Wilson & Murphy, 1996). The fact that force is measured at single joint position which is not specific to the performance of most human activities has been the major argument against isometric testing, pointing out that its relationship with dynamic activities is questionable (Abernethy, et al., 1995). Additionally, the underlying neural activation pattern of isometric tests could be different from the same pattern in rapid and cyclic movements, or a relatively long and fatigue-prone procedure based on a sustained contraction, which could be inappropriate for some populations, such as injured or elderly (Abernethy, et al., 1995; Enoka & Fuglevand, 2001; Jaric, Radosavljevic-Jaric, & Johansson, 2002; Pua, et al., 2008).

Regarding the shortcomings of standard isometric test related to neural activation pattern, a novel strength tests based on isometric Consecutive maximum contractions CMC (Suzovic, et al., 2008) and Alternating consecutive maximum contractions ACMC (Bozic, Suzovic, Nedeljkovic, & Jaric, 2011; Bozic, Pazin, Berjan, & Jaric, 2012) have been proposed recently in order to overcome them. The selection of the tests has been made on their partial similarity to the muscle action regime typical for various rapid and cyclic movements.

Both CMC and ACMC tests have been evaluated on healthy and physically active subjects, while ACMC test has been also evaluated on ACLR population, and the findings revealed that, when conducted on self-selected frequency, variables had relatively stable values and proved to be reliable (Knezevic, Mirkov et al. 2012). The novel test had sufficient longitudinal validity, while the concurrent validity (with respect to the isokinetic tests) appeared to be comparable with the validity of standard isometric strength test. Although these properties proved to be comparable with the standard isometric test, ACMC retains important methodological advantages, such as a brief and simple procedure for testing two antagonistic muscles, as well as exposing the muscle and joint tissues to relatively low and transient forces. Based on the evaluation both on healthy subjects and ACLR, the results suggest that ACMC could be developed as a test of neuromuscular function that could be either alternative or complementary to standard isometric test.

Isoinertial Strength Assessment

Isoinertial tests (previously known as isotonic) are based on limb movement against constant external load (Abernethy, et al., 1995). These tests are used to assess muscle strength and power. In healthy subjects maximum isoinertial strength is most commonly assessed through 1 repetition maximum (1 RM) for a particular task (Abernethy, et al., 1995; Wilson, Lyttle, & Murphy, 1995). Another way to assess both strength and power under isoinertial conditions is using linear encoders to measure the load displacement of any machine using gravitational loads as external resistance (e.g., seated leg extension and flexion in OKC, or leg press, dips, pull down etc. in CKC), which allows the calculation of muscle power during dynamic movements. In the latest years, the isoinertial assessment has been favorized by some researches because it allows "the most natural pattern of movement of the human limbs, which apply force to an external load that is accelerated, and allows the achievement of all ranges of velocities" (Pigozzi, et al., 2012). However, those against isoinertial assessment tend to emphasize poor reliability and objectivity due to inter-subject, inter-trial and inter-laboratory variations (Abernethy, et al., 1995).

Tests of muscle power

In most tests of muscle power, mechanical outputs such as force, velocity, or work done are measured (Abernethy, Wilson et al. 1995; Nedeljkovic, Mirkov et al. 2009; Nedeljkovic, Mirkov et al. 2009). The measures are usually taken from complex movements, including cycling and rowing (e.g., Wingate test), running (e.g., Margaria staircase test), jumping (e.g., squat jump with weights, repeated rebound jumps, drop jumps), or throwing (e.g., concentric bench or shoulder press throw). However, as the success in these rapid movements highly depends on muscular power, the recorded performance of such movements (e.g., the height of a maximum vertical jump, or maximum running or throwing velocity) have been often considered as indices of muscle power output per se in complex batteries of physical ability testing frequently applied in sports, physical education and other human movement related fields (Abernethy, Wilson et al. 1995; Nedeljkovic, Mirkov et al. 2009; Nedeljkovic, Mirkov et al. 2009). The implicit rationale for that has been based on the limited time available for work done (i.e., muscle work responsible for an increase in potential or kinetic energy in movements such as jumping, running, or throwing).

Role of Body Size

Among many factors that could confound results of muscle strength and power tests (e.g., age, gender, body composition, skill, level of physical activity and training) (Batterham and George 1997; Nedeljkovic, Mirkov et al. 2009) body size has proven to be an important one. Even common knowledge suggests that the taller and heavier individuals are more powerful than shorter and lighter ones. Although, some authors present their data normalized for body size, a recent review revealed that the most of the data reported throughout the literature were either non-normalized or normalized using inappropriate methods (Markovic and Jaric 2005). As a consequence, a number of the previously reported results of physical performance testing have been body size dependent, while the relationships between different tests have been confounded by the body size effect. Another consequence is that comparisons of the data obtained in different studies have been often invalid which has prevented researchers from establishing normative values for various tests applied on particular populations.

The relationship between physical performance and body size has been studied both theoretically and experimentally. The simplest theoretical approach has been based on the presumption of geometric similarity and the following allometric model:

$$P = aS^b \quad \text{(Eq. 1)}$$

where P is the tested physical performance, S is a selected index of body size, b is allometric exponent, while a is a parameter corresponding to "normalized" performance (see further text for details). For example, body mass (proportional either to volume or to linear dimensions on power 3) of "geometrically similar" individuals increases at a higher rate with body size than muscle strength and power (proportional to the muscle cross-sectional area – linear dimensions on power 2). Therefore, if body mass were selected to represent the body size, the tests of exertion of external force and power should reveal the allometric exponent b = 2/3 = 0.67 (Jaric 2002; Jaric, Radosavljevic-Jaric et al. 2002; Markovic and Jaric 2005; Nedeljkovic, Mirkov et al. 2009; Nedeljkovic, Mirkov et al. 2009). As a consequence, the properly normalized results of a particular performance test should be calculated as:

$$P_n = P/S^b \quad \text{(Eq. 1)}$$

where b = 0.67, while P_n corresponds to parameter a of Eq.1.

In our recent studies we have examined the above presented relationship between a wide range of muscle strength and power tests and body size, in order to propose appropriate normalization for body size in routine tests of muscle strength and power output.
The main results of the study are summarized in Table 1.

Table 1. Comparison of the experimentally obtained values of allometric exponents [34,44,50] with those predicted by the theory of geometric similarity

Test		Experimentally obtained allometric exponent	Theoreticaly recommended allometric exponent	Reference
Strength tests (Force)	F_{MAX} (elbow, hip and knee flexors and extensors)	0.45	0.67	Jaric et al. [34] (N=16)
Strength tests (Torque)	T_{MAX} (elbow extensors)		1	
	T_{MAX} (elbow flexors)	0.97		
	T_{MAX} (knee extensors)	1.01		
	T_{MAX} (knee flexors)	1.39		
	T_{MAX} (hip extensors)	1.28		
	T_{MAX} (hip flexors)	0.41		
Explosive force production tests	*RFD* (elbow extensors)	0.32	0.67	Mirkov et al. [50] (N=26)
	RFD (elbow flexors)	0.52		
	RFD/F_{MAX} (elbow ext.)	0.05	0	
	RFD/F_{MAX} (elbow flexors)	0.17		
	$F_{30\text{-}70\%}$ (elbow extensors)	0.03		
	$F_{30\text{-}70\%}$ (elbow flexors)	-0.09		
Tests of exertion of external force	Isometric squat	0.94	0.67	Markovic and Jaric [44] (N=77)
	Back squat	0.42		
	Bench press	0.69		
	Triceps extension	0.58		
	Biceps curl	0.65		
	Hand grip	0.27		
Tests of supporting body weight	Sit ups	-0.30	-0.33	
	Push ups	-0.42		
	Pull ups	-1.08		
	Parallel bar dips	-0.55		
	One leg rising	-0.51		
	Hanging leg raises	-0.38		
Tests of rapid movements	Squat jump	-0.01	0	
	Counter movement jump	-0.03		
	Standing long jump	0.06		
	Standing ball kick	0.13		
	Throwing ball	0.36		
	Sprint 20 m	0.05		

F_{MAX} – maximal force; T_{MAX} – maximal torque; *RFD* – rate of force development; $F_{30\text{-}70\%}$ – the time interval elapsed between achieving 30% and 70% of F_{MAX}

In short, the findings have revealed that:

1. Muscle force, as proportional to the muscle physiological cross-sectional area (i.e., proportional to $m^{2/3}$), should increase with body size proportionally to $m^{2/3}$.

2. The muscle torque that can be exerted about a particular joint, however, depends on muscle force (proportional to $m^{2/3}$) and muscle lever arm (as any other length proportional to $m^{1/3}$) which gives as a product $m^{2/3} \times m^{1/3} = m$. As a result, joint torque should increase at a higher rate with body size than muscle force, and should be proportional to m (Jaric, Radosavljevic-Jaric et al. 2002).

3. Direct tests of muscle power [muscle force should be proportional to $m^{2/3}$ and velocity should be independent of body size, should also be proportional $m^{2/3}$ (Nedeljkovic, Mirkov et al. 2009).

4. In indirect tests of muscle power, based on theoretical presumption that velocity does not change with body size the performance of rapid movements (e.g., sprinting, jumping, throwing lighter objects) should not be body size dependent, although the recorded muscle power in those tests should be proportional to $m^{2/3}$ (see previous text) (Nedeljkovic, Mirkov et al. 2009).

5. Exercise performance tests, based on muscle actions aimed to support body weight under strength-demanding conditions. (e.g., push-ups, sit-ups, pull-ups, body-weight squats) and to sustain particular postures (e.g., keeping the back extended in horizontal position, maintaining balance position in gymnastics) should be negatively related to body size [Since body weight increases proportionally to body mass (i.e., proportionally to m^1; see previous text), while the muscle force needed to overcome the body weight increases at a slower rate (proportionally to $m^{2/3}$), the performance of this group of functional tests should be proportional to $m^{2/3} / m^1 = m^{-1/3}$] (Markovic and Jaric 2004).

CONCLUSIONS

The assessment of strength and power has an important place in a number of both clinical and non-clinical human movement related areas. Through the time, various methods and instrumentations have been developed. Regardless of the applied protocols, measuring outcome depends on the variety of factors, which should be controlled in order to obtain valid and reliable outcome. Among the factors that could confound results of muscle strength and power tests body size has proven to be an important one. Therefore, appropriate normalization for body size in routine tests of muscle strength and power should be applied.

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Papers from Oral Presenters

Effects of Cool Water Immersion on Time Trial Performance of Endurance Cyclists in the Heat

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Abstract

The purpose of this study was to investigate the effects of acute cool water immersion (CWI) at 25°C after prolonged submaximal (70% of VO_{2max}) cycling exercise on subsequent time trial performance as compared to air cooling (AC) at 25°C. Ten trained male cyclists (age: 18.9 ± 4.5 years; body weight: 52.9 ± 4.2 kg; height: 164.4 ± 3.3cm; and VO_{2max}: 57.6 ± 3.6 ml.kg-1.min^{-1}) representing Kelantan state, were recruited for this study. This study was a randomized crossover trial design comprising of 60 minutes of cycling on a cycle ergometer at 70% VO_{2max}, followed by a 30 minutes of cooling protocol for recovery, and subsequently a 20 km cycling time trial test on an indoor bike trainer. Heart rate, oxygen consumption (VO_2) and rectal temperature (T_{rec}) were monitored during the experimental trials. Environmental conditions were controlled at an ambient temperature of 31.2 ± 0.3 °C and relative humidity of 72.0 ± 0.7 %. Prior to the start of 20 km time trial, T_{rec} of CWI trial was significantly ($p < 0.05$) lower than the AC trial (36.1 ± 0.3 °C vs 37.1 ± 0.3 °C respectively). Similarly, resting heart rate of the subjects in the CWI trial upon cooling was significantly ($p<0.05$) lower than the AC trial (61.9 ± 10.0 beats.min^{-1} vs 89.9 ± 8.3 beats.min^{-1}). Average time trial speed in the CWI trial was significantly ($p<0.05$) faster than the AC trial (27.4 ± 2.1 km.h^{-1} vs 25.9 ± 2.4 km.h^{-1}). Time to complete the 20km time trial in the CWI trial was significantly ($p<0.05$) shorter than the AC trial (43.8 ± 3.3 min vs 46.4 min ± 4.5 min respectively). During the time trial, it was found that T_{rec} in the CWI trial was significantly ($p<0.05$) lower than the AC trial (37.8 ± 0.4 °C vs 38.5 ± 0.7°C respectively). However, there were no significant differences in oxygen uptake during both time trials. (CWI = 40.0 ± 5.4 mL.kg-1.min^{-1} vs AC=38.9 ± 5.4, mL.kg^{-1}.min^{-1}). These data indicated that cool water immersion at 25°C was able to lower core body temperature effectively and improving time trial performance of endurance cyclists in a hot and humid condition compared to normal air cooling.

INTRODUCTION

With the general acceptance that high ambient temperature and humidity have detrimental effects on athletes, the importance of controlling core body temperature and the topic on whole-body cooling began to receive attention during the 1980's (Quod *et al.*, 2006). Various cooling interventions have been developed to counter these problems, such as

cooling vest (Lopez *et al.*, 2008), head cooling (Hara *et al.*, 2008), neck cooling (Hara *et al.*, 2008), cold water immersion (Taylor *et al.*, 2008), whole body cryotherapy, ice massage and etc (Dykstra *et al.*, 2009). Various forms of cooling has been reported to improve exercise time to exhaustion (Gonzalez-Alonso *et al.*, 1999), reduce thermal strain (Kay *et al.*, 1999), reduce muscle soreness, improve restoration of muscle strength and recovery (Reilly *et al.*, 2002), as well as alleviating oxidative stress (Dugue *et al.*, 2005; Wozniak *et al.*, 2007; Lubkowska *et al.*, 2008) and muscle damage (Reilly *et al.*, 2002). However, the specific effects of cooling on the recovery profile and subsequent performance of athletes has not been studied thoroughly.

Among these interventions, cold water immersion resulted in the most effective cooling reported so far compared to other cooling methods (Proulx *et al.*, 2003). Despite a lack of scientific research and understanding about how it works with our body, application of cold water immersion as a recovery strategy following prolonged high-intensity exercise has become increasingly popular in the world of sports. Apart from the use of cold water immersion as a post-exercise recovery intervention, it has also been applied as a cooling strategy before sports activity (pre-cooling). Most of the studies in the literature applied cold (ice or cold water, 2℃ - 20℃) and extreme cold (sub-zero ℃) temperatures while investigating the effects of cooling, mainly to ensure that it generates a thermal gradient which is steep and long lasting enough during an exercise (Taylor *et al.*, 2008).

However, Taylor and co-researchers (2008) demonstrated that rapid and effective heat removal can be achieved during a temperate-water (26℃) immersion, or better known as cool water immersion. Indeed, no significant difference in cooling rates of esophageal temperature were observed from one another across any of the water temperatures investigated, a fact that appears to have escaped the attention of ice-cold water enthusiasts. Taylor and co-researchers (2008) also reported that respective cooling times using water temperature of 14℃ and 26℃ were both below 4 min, which raised questions on the need to use water cooler than 14℃, or perhaps even 26℃. The risk of lethal cold-shock responses while applying cold water should be taken into consideration as well. It has been shown that a rapid, effective and comfortable cooling could still be achieved in hyperthermic individuals using temperate water temperature, while simultaneously avoiding the risk of cold-shock responses (Taylor *et al.*, 2008).

Studies that relate changes in core body temperature on recovery, fatigue and time trial performance using temperate water temperature (25-26℃) are still lacking in the literature. Limited research has been done to test the effects of cool water immersion (25℃) on subsequent time trial performance. When examining the practical considerations of cooling, there are several aspects that need to be considered, which include transport, cost, ease of application, access to power, water supply, refrigerators, staff and technical support, athlete comfort and pre-event routine and etc. Application of cold or extreme cold water immersion has give rise to many logistic issues to the athletes and the entire sports team during the actual event. Supply of cold water, ice cubes, electrical supply (for specific cooling device) and space setup are often limited in grand international events that involve thousands to tens of thousands of athletes, not to mention about the finance cost. Further exploration and validation on the effectiveness of using temperate water temperature on cooling rate, fatigue and exercise performance might give another hope in solving these problems.

METHODS

Research Design

A randomized cross-over design was employed for the present study. 2 separate trials were performed whereby subjects were their own control. A standard rest interval of 7 days between each trial was given to ensure that the subjects are fully recovered before they go through the next trial.

Subjects

Ten trained male cyclists representing Kelantan state, with age ranging from 15-25 years were recruited for this study. Subjects were given explanation to the nature and risks of the experiment procedures and a written informed consent were obtained. The protocol was approved by the Human Ethics Committee of Universiti Sains Malaysia. Subjects were requested to control on their diet 3 days prior to trial, and also refrain from training the day before the experimental trial. All selection and familiarization trials, as well as the experimental trials were conducted at the Sports Science Laboratory, Sports Science Unit, Universiti Sains Malaysia (USM). Subjects who were unable to cycle at 70% of VO_{2max} for at least 1 hour on the cycle ergometer during the familiarization trial were excluded from this study. Subjects with history of chronic disease such as hypertension, cardiovascular disease, respiratory problems, thermoregulatory problems, diabetes, any injury, or any other major problems contraindicative of participation were excluded as well.

Procedures

Four pre-trial visits were conducted to determine the $VO_{2max,}$ measurement of sub-maximal oxygen consumption, indoor time trial performance and a familiarisation of the test protocol. VO_{2max} and sub-maximal oxygen consumption test were performed on a cycle ergometer (Lode Excalibur Sport, Nederland). Appropriate cycling workload during warm-up at 50% VO_{2max} and endurance cycling at 70% VO_{2max} in the actual experimental trials were established from the results of these two tests. Subjects were required to familiarize with indoor stationary cycling and time trial performance. A standardised road bike (Trek 1200, USA) was used for each subject during time trial performance. Each subject performed their individual time trial by riding the road bike on an indoor bike trainer (JetFluid^{TM} Pro Trainer, USA). Then, a familiarization trial was carried out 2 – 3 days later to familiarise the subjects with the experimental protocol. Subjects were required to cycle in the heat (31°C, 70% relative humidity) at 70% VO_{2max} on a cycle ergometer for 60 minutes, followed by a cooling period of 30 minutes immersing in cool water at 25°C. Subsequently, subjects were required to perform a 20km time trial, riding the road bike on the indoor bike trainer.

On the day prior to the experimental trial, subjects were required to undergo an overnight fasting of 10-12 hours before starting the trial. However, subjects were allowed to drink plain water. Subjects were asked to void their bladder before nude body weight is measured. Nude body weight was then measured by using body composition analyser (Tanita® TNF-410). Core body temperature was monitored throughout the test, by inserting a rectal probe to a depth of 10-12 cm beyond anal sphincter. Subjects were given 500ml of water to ensure there are well-hydrated and a standardized breakfast of 2 slices of bread (Gardenia) one hour before starting the trial.

Heart rate monitor (Polar S710, Finland) was fitted on the chest of the subject, right below their pectoral muscles. An indwelling cannula (Vosacan Brannule Indwelling Cannula, Braun, Germany) was inserted into subcutaneous forearm vein for blood sample collection. 10 ml of blood was taken for baseline measurement using a 10 ml Latex Free Syringe (Becton Dickinson, United States). A head gear and the breathing apparatus were fitted to the subject and then connected to the gas analyser for determining the oxygen consumption. Each trial consists of 4 stages: a) Warm up at 50% VO_{2max} for 5 minutes, b) Cycling at 70% VO_{2max} for 60 minutes (31°C, relative humidity 70%), c) Cooling period of 30 minutes and d) 20km time trial.

Nude body weight was taken after subject completed 60 minutes of cycling at 70% VO_{2max}. 4ml of sports drink (100plus) per kg of body weight were given after riding at 70% VO_{2max} for 60 minutes. For the air-cooling trial, each subject rested for 30 minutes in an air-conditioned room maintained at 25°C, whereas in the cool water immersion trial, the subjects were subjected to 30 minutes of cool water immersion at 25°C. Total time taken to complete the time trial of 20km was used as the indicator of endurance cycling performance after the 30 minutes of cooling recovery period. Core body temperature was monitored throughout the whole session, and nude body weight was recorded upon cooling and the end of the trial. Blood samples collected at each stage were analysed for changes plasma glucose and lactate levels. Upon blood collection at each interval, the blood cannula was flushed with sterile heparinized saline solution (10 IU/ ml) to prevent blockage of the channel. A standard rest interval of 7 days between each trial was given to ensure that the subjects have fully recovered before they go through the next trial.

Blood sample collection and analysis

10 ml of blood were drawn at each 20 min interval during 1hr cycling at 70% VO_{2max}, every 15 minutes during the 30 minutes of cooling recovery, as well as every 10km distance completed during the 20km time trial respectively. 2 ml of blood sample taken at every interval was mixed with sodium fluoride (NaFl) and centrifuged at 5,000 rpm at 4°C for 10 minutes to separate the plasma from the anti-coagulated blood sample. The plasma extracted was stored at -80°C for later analysis of plasma glucose and lactate concentrations.

Statistical Analysis

Statistical analysis was carried out using the SPSS version 19.0 software. Two-way repeated-measures analysis of variance (ANOVA) followed by paired t-test was used to analyse the data. The criterion for statistical significance was set at $p<0.05$. The results were reported as means ± S.D. (Standard deviation)

RESULTS

The mean values of anthropometrical and physiological characteristics of the nine subjects were presented in Table 1. A significant ($p<0.05$) difference was observed in time trial performance between both trials. On average, subjects were able to complete the 20km time trial in an average time of 44 minutes during the CWI trial, which was 2.7 ± 1.9 minutes faster than the AC trial. The difference in average speed (25.9 ± 2.4 $km.h^{-1}$ and 27.4 ± 2.1

$km.h^{-1}$ respectively for AC and CWI) was also equivalent to a 6% improvement in time trial performance (Table 2).

Room temperature in both AC and CWI trials was 31.2 ± 0.3 and 31.2 ± 0.4 °C respectively while relative humidity in both AC and CWI trials was 71.9 ± 0.9 and 72.1 ± 0.6 % respectively. There were no significant differences in mean room temperature and relative humidity between AC and CWI trials. Mean oxygen uptake significantly increased over time in both AC and CWI trials. However, there was no significant difference between both trials at any time point.

Table 1: Anthropometrical and physiological characteristics of subjects (n=9). Values are means ± standard deviation

Parameters	Means ± standard deviation
Age (years)	18.9 ± 4.5
Standing Height (cm)	164.4 ± 3.3
Body Weight (kg)	52.9 ± 4.2
Maximum oxygen uptake ($mL.kg^{-1}.min^{-1}$)	57.6 ± 3.6
Body fat percentage (%)	16.7 ± 1.8

Table 2: Time taken and average riding speed during 20km time trial of both trials (n=9)

Measurements	Mean ± S.D.	
	AC	CWI
Time (min)	46.7 ± 5.4	**44.0 ± 2.7***
Average speed (km/h)	25.9 ± 2.4	**27.4 ± 2.1***

* denotes a significant difference between AC and CWI ($p<0.05$)

During the 1hr cycling at 70% VO_{2max}, both trials exhibited similar trend in heart rate response and no significant difference in heart rate was observed (Fig. 1). There was also no significant difference in heart rate achieved after 60 minutes of cycling for AC trial and CWI trial (168.4 ± 4.8 and 166.33 ± 10.4 $beats.min^{-1}$ respectively). However, there was a significant difference in heart rate during the 30 minutes cooling period between both trials. Heart rate of CWI trial was significantly ($p<0.05$) lower than that of AC trial between 5 – 30 minutes upon the start of cooling. After 30 minutes of cooling, it was found that resting heart rate prior to the start of 20km time trial for CWI trial was significantly ($p<0.05$) lower than that of AC trial (61.9 ± 10.0 $beats.min^{-1}$ vs. 89.9 ± 8.3 $beats.min^{-1}$).

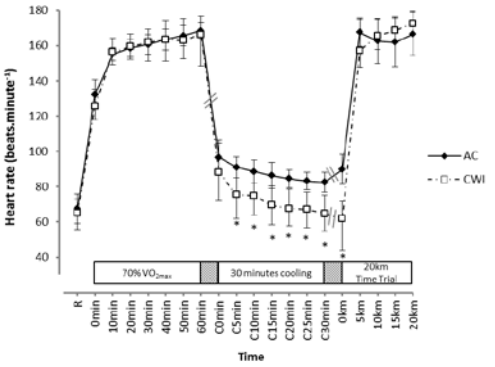

Figure 1: Heart rate of subjects during 1 hour of cycling, 30 min of cooling and 20km time trial in both trials. * denotes a significant difference between AC and CWI at respective intervals ($p<0.05$)

T_{rec} gradually increased throughout the one hour ride at 70% of VO_{2max}. During this period, both trials exhibited similar trend and no significant difference in T_{rec} was observed (Fig. 2). There was no significant difference in T_{rec} following 60 minutes of cycling for AC trial and CWI trial (38.6 ± 0.3 °C and 38.6 ± 0.6 °C respectively). However, there was a significant difference in T_{rec} during the 30 minutes cooling period between both trials. T_{rec} of CWI trial was significantly ($p<0.05$) lower than that of AC trial after 15 – 30 minutes of cooling. After 30 minutes of cooling, it was found that resting T_{rec} prior to the start of 20km time trial for CWI trial was significantly ($p<0.05$) lower than that of AC trial (36.2 ± 0.3 °C vs. 37.1 ± 0.3 °C). Throughout the entire 20km time trial, it was found that T_{rec} in the CWI trial was significantly ($p<0.05$) lower than the AC trial. At the end of the time trial, T_{rec} for CWI trial was significantly ($p<0.05$) lower than that of AC trial (37.8 ± 0.4 °C vs. 38.5 ± 0.7°C respectively).

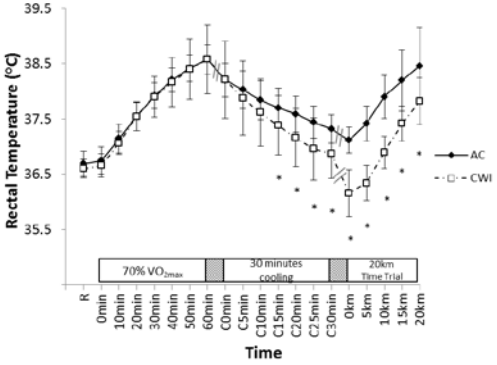

Figure 2: Rectal temperature (T_{rec}) of subjects during 1 hour of cycling, 30 min of cooling and 20km time trial in both trials.* denotes a significant difference between AC and CWI at respective intervals ($p<0.05$)

Plasma glucose concentrations significantly decreased (P<0.05) over time (Fig. 3). whereas plasma lactate significantly increased (P<0.05) over time (Fig. 4). However, these parameters were not significantly different between AC and CWI trials at any time point.

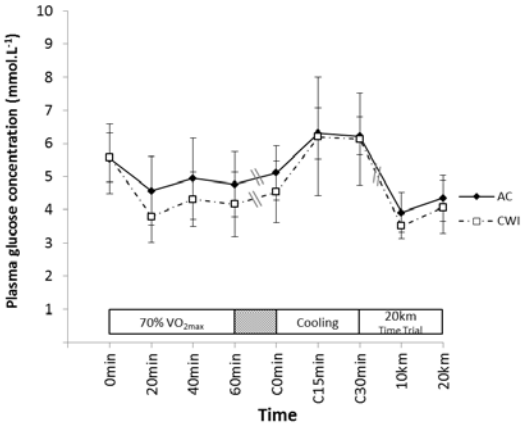

Figure 3: Plasma glucose concentration of subjects during 1 hour cycling at 70% VO_{2max}, 30 minutes of cooling and 20km time trial.

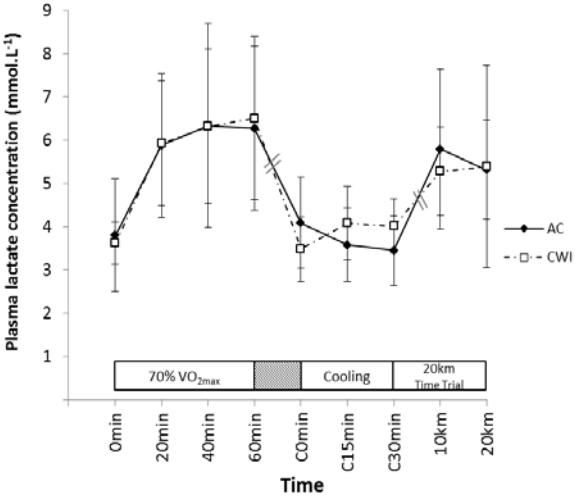

Figure 4: Plasma lactate concentration of subjects during 1 hour cycling at 70% VO_{2max}, 30 minutes of cooling and 20km time trial.

DISCUSSION

The most notable finding in the present study was during the CWI trial, average speed (Table 2) during the 20km time trial was 6% ($p<0.05$) faster than that of AC trial. Time taken to complete the 20km time trial (Table 2) in the CWI trial was shorten by 2.7 ± 1.9 minutes compared to AC trial ($p<0.05$). It has been well documented by other researchers that cooling can give rise to improvement in endurance cycling performance, particularly in cycling speed (Kay et al., 1999), and also delay the onset of fatigue and thus extend the time to exhaustion of endurance cyclists (Gonzalez-Alonso et al., 1999; Ansley et al., 2008). However, most of the literature available emphasise on using an intense cooling temperature ranging from 2°C - 10°C (Proulx et al., 2003; Quod et al., 2006). Although most of these studies reported improvement in endurance cycling performance, limited research findings are available for temperature water temperature at 25°C. Our findings show that cool water immersion (25°C) are not only able to reduce core body temperature effectively ($p<0.05$) within fairly short period of time; 30 minutes immersion, but also significantly improved ($p<0.05$) 20km time trial performance of endurance cyclists.

It was found that the increase in heart rate has a linear relationship with rectal temperature as well, which contributed to the increase in cardiovascular demand. Heart rates began to differ significantly ($p<0.05$) between both trials when subjects underwent the 30 minutes of cooling at respective cooling methods. Although the cooling temperature used was the same, which was 25°C for both the air and water temperature, CWI elicited a more rapid and effective cooling rate than air cooling itself. Heart rate of CWI trials was significantly lower than AC trials just after 5 minutes of cooling. As a result, rectal temperature in CWI trial was significantly lower than AC trial upon 30 minutes cooling, or just before the subjects began their 20km time trial (36.2 ± 0.1°C vs. 37.1 ± 0.1°C; $p<0.05$). Since it well documented that hyperthermia will induce an increase in skin blood flow and sweat rate (Nielsen et al., 1993), and shunts systemic blood flow to the skin for heat dissipation rather than supplying blood to active muscles (Hunter et al., 2002), the difference in heart rate was mainly due to the difference in heat and rectal temperature. Since rectal temperature in CWI trial rapidly decrease back to resting levels, or even lower (Figure 2), there was no need for the heart to work harder for the purpose of heat dissipation. It was also found that after 5km into the time trial, heart rates in AC trial was higher than CWI trial (167.6 ± 2.7 beats.min^{-1} vs. 157.1 ± 6.0 beats.min^{-1}) although the time taken to complete the first 5km time trial of CWI trials was faster than AC trials (10.9 min vs. 11.2 min). Although statistical significance was not indicated, it was postulated that the subjects in CWI trials were able to cycle faster and yet have a lower exercise heart rate than subjects in the AC trials, since the rectal temperature was lower and there are less burden given on the cardiovascular system for heat dissipation purpose.

Rectal temperatures achieved after 1 hour of cycling at 70% VO_{2max} were 38.6 ± 0.1°C and 38.6 ± 0.2°C respectively for AC and CWI trial. Thus, the subjects in this study did not reach critical core body temperature of ~39.5°C. This could be attributed to difference in exercise duration and heating protocol (exercise intensity and environmental temperature) compared to other previous studies (Proulx *et al.*, 2003; Quod *et al.*, 2006; Taylor *et al.*, 2008). Other factors such as training status of the cyclists and heat acclimatisation may have influenced the extent of hyperthermia after exercise. They have been adapted to exhaustive exercise under hot and humid conditions for exercise duration which was longer than 2 hours during their training sessions. In the present study, there was a significant difference ($p<0.05$) in rectal temperature between AC and CWI trial from minute 15 and

onwards. Water has a much higher heat storage capacity than air, thus water is able to exert a much rapid and effective cooling rate as compare to air. Taylor and colleagues (2008) revealed a cooling rate of esophageal temperature (T_{es}) of 0.88 ± 0.06 °C.min^{-1} using water temperature of 14°C and 0.71 ± 0.02 °C.min^{-1} using water temperature of 26°C. These differences in cooling rate could be due to the difference in body temperatures that subjects achieved and the water temperature applied in the cooling protocol. The study done by Taylor and colleagues (2008) measured the time taken to decrease T_{es} from 39.5°C to 37.5°C. As a result, the difference in thermal gradient had a major influence on net heat loss. Furthermore esophageal temperature is more sensitive to the core body temperature changes compare to rectal temperature.

In another similar study, a cooling rate of T_{rec} of 0.15 ± 0.06°C.min^{-1} using water temperature of 14°C was reported (Proulx *et al.*, 2003). The current guidelines on treatment for hyperthermic individuals states that any treatment modality should achieve a T_{rec} cooling rate of at least 0.10°C.min^{-1}, which is most effectively achieved in cold water immersion (Casa *et al.*, 2007). In the present study, highest T_{rec} cooling rate of 0.06°C.min^{-1} was achieved, where T_{rec} decreased from 38.2°C to 37.6°C in the first 10 minutes of cool water immersion. However, the figure may not be comparable with other previous studies as it differs with other studies in the aspect of heating protocol (exercise intensity and environmental temperature) and end point body temperature upon exercise. Previous studies by Taylor et al. (2008) and Proulx et al. (2003) required their subjects to exercise until temperature reaches 39.5 – 40.0°C and cooling rates were measured at the decrease of temperature from 39.5 – 40.0°C to 37.5 – 38.0°C. It was also reported by Proulx et al. (2003) that cooling rates from 40.0°C to 39.0°C and from 39.0°C to 38.0°C were higher than the average cooling rates from 40.0°C to 37.5°C, not to mention about 38.0 – 37.0°C itself. Therefore, it was known that cooling rates were much higher at higher temperature zones. In fact, Proulx et al. (2003) did not report any significant difference in cooling rates from 40°C to 38°C across three different water temperatures at 8°C, 14°C and 20°C. Only extreme cold water temperature at 2°C managed to achieve cooling rates that was significantly greater than all three other water temperatures.

During the 20km time trial, we found that not only rectal temperature of CWI was significantly lower than AC by 0.96°C at baseline; rectal temperature of CWI was still significantly lower than AC by 0.64°C at the end of the trial (Fig. 2). Rectal temperature in CWI trials did not go beyond 38.0°C in the 20km time trial that lasted longer than 40 minutes, indicating that rectal temperature was still within optimum range for exercise performance. This showed that the cooling effects arise from cooling using water temperature of 25°C was sustainable in a 20km time trial or duration of 40 minutes. During the 20km time trial, the difference in rectal temperature between AC and CWI trials at baseline was 0.96°C and this difference was reduced to 0.64°C at the end of 20km. Although this difference was significant, there was a 0.32°C reduction. One of the possible explanations for this was because subjects were cycling 6% faster in average speed during CWI trial than AC trial. This leads to a greater energy utilisation which resulted in greater heat generation, causing rectal temperature to increase in a higher rate in CWI trial during 20km time trial.

In the present study, plasma glucose levels for both AC and CWI trials declined once the subjects began to cycle at their respective 70% VO_{2max} (Fig. 3). This indicated that the onset of exercise accelerated the utilisation of glucose. As the subjects stopped for rest following an hour of cycling and were given 4 ml.kg^{-1} body weight of sports drink (100plus), glucose

concentration increased significantly ($p<0.05$) after 15 minutes of cooling, before decreasing significantly ($p<0.05$) again in the 20km time trial. Glycogen storage decline of up to 61% has been reported during high intensity time trials (Dennis *et al.*, 1997; Brooks *et al.*, 2000). Furthermore, subjects in this study were assigned to cycle for 1hr at 70% VO_{2max} prior to the time trial and thus were experiencing a greater exertion in depletion of carbohydrate fuels. Hence, plasma glucose level was at lowest at the 10km time point during the 20km time trial, and it was significantly lower than respective resting values. It has been reported that during endurance exercise, the intracellular glycogen stores gradually decreases and the muscle tissue gradually increases its consumption of blood glucose. Subsequently, the availability of glucose will no longer be able to meet the demand of glucose consumption and the concentration of blood glucose may even decrease (Ament and Verkerke, 2009).

Hyperthermia will increase the cardiovascular demand during exercise as it shunts more blood flow to the skin for heat dissipation than supplying blood to active muscles (Hunter *et al.*, 2002). Therefore, it was postulated that this will create a stressful scenario for the circulatory system as higher cardiac output is associated with higher energy expenditure and thus result in greater substrate utilisation and depletion. Plasma glucose levels in this study, however, showed no significant difference between both trials (Figure 3), although it was observed that there was a significant difference in heart rate between both trials (Fig. 1). In previous studies, it has been reported that cold water immersion did not elicit any changes in plasma glucose between trials (Gonzalez-Alonso *et al.*, 1999; Halson *et al.*, 2008). It is postulated that if subjects were instructed to cycle at a same given speed during the time trial in both trials, subjects might have spared more carbohydrate stores during the recovery period and plasma glucose level of CWI trial would be higher than AC trial. Exercise performance had been the primary focus of the research, the advantage of CWI treatment in sparing carbohydrate during exercise might have been counterbalanced by a higher rate of exercise during the time trial, and thus no significant differences in plasma glucose level can be seen.

In the present study, plasma lactate increased significantly ($p<0.05$) over time after both 1hr cycling at 70% VO_{2max} and 20km time trial compared to respective resting values in both trials. Similar trend was reported in other previous studies (Gonzalez-Alonso *et al.*, 1999; Wong *et al.*, 2011). It has been reported that subjects in this study were 6% faster in the 20km time trial during CWI trial than AC trial. Yet, no significant difference was observed in lactate levels during the 20km time trial between both trials and mean values of lactate levels were not statistically different between trials (Fig. 4). One of the most notable cooling study performed by Gonzalez-Alonso et al. (1999) reported similar findings as well. Since heat will affect the efficiency of our blood flow in supplying oxygen and nutrients (Hunter *et al.*, 2002), it would have affect lactate removal of the muscles as well. It is thus postulated that there was an enhanced blood lactate removal during CWI trial which enables the subject to have the extra capacity to resist fatigue and cycle faster during the 20km time trial. However, since many different exercise intensities have been used by previous researchers, it is difficult to come into generalisations regarding the effect that cold exposure has on exercise metabolism (Shephard, 1993).

CONCLUSIONS

Data from the present study indicated that time trial performance of the subjects were significantly faster in the CWI trial. Under the conditions set up for this study, we conclude that cool water immersion (25°C) significantly improved time trial performance of endurance cyclists. It has been shown that a rapid, effective and comfortable cooling could still be achieved in hyperthermic individuals using temperate water temperature of 25°C, while simultaneously avoiding the risk of cold-shock responses. 30 minute of cool water immersion significantly lowered the resting heart rate and core body temperature prior to the subsequent bout of exercise. Cool water immersion (25°C) did not seem to have any effect on the selected physiological parameters measured such as VO_2, plasma glucose and plasma lactate.

ACKOWLEDGEMENTS

Our appreciation extends to *Madam Jamaayah, Madam Norlida, and Ms. Hafizah* from the Sports Science Laboratory, Health Campus, Universiti Sains Malaysia, Kelantan, Malaysia for their technical support in lab and their kind assistance in this project. Last but not least, our gratitude to all subjects who participated in this study.

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Efficiency and Variety of Attacking Actions in Junior and Senior Taekwondo Players' Match

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Abstract

Extensive research has been attempted recently by implementing video/notational analysis in sports, given that its benefits in improving performance have been shown to exist. The present study was conducted to determine whether the taekwondo juniors and seniors athletes differ in: (1) opting for high-scoring kicks, (2) the attacking techniques efficiency; and (3) fatigue pattern during their competitive matches. A total of 38 matches of the 11 seniors and 10 juniors in a national level taekwondo competitions were analyzed for the frequency and efficiency of the techniques used through notational analysis across the three rounds of a match. The results of chi-square revealed significant differences ($P<0.05$) between the 2 groups on the preferred techniques used during their matches but there were no significant differences found between them on the preferred techniques used in accordance to technique groups (i.e. 1-, 2-, and 3-point scoring techniques). Seniors were better in performing 1- and 2-point techniques while juniors were better in performing 3-point techniques. Seniors have had significantly higher overall techniques efficiency ($P<0.05$) than the juniors. Across rounds of a match, seniors have had significantly ($P<0.05$) better techniques efficiency than the juniors in the rounds 2 and 3 of the match. Juniors' techniques efficiency declined across rounds but seniors managed to achieve the best techniques efficiency in the final round though it kept deteriorating from rounds 1 to 2. In order to achieve technical efficiency similar to that of the seniors, juniors need to improve their 1- and 2-points techniques while continuing to polish 3-point techniques. Coaches are encouraged to plan training program to improve both ATP-CP pathway necessary for high-intensity techniques along with aerobic capacity required for sustaining high match pace and technique efficiency of the fighters so that they could perform equally good in all three rounds.

INTRODUCTION

Taekwondo is one of the Korean traditional martial arts. Its component of *kyorugi* (sparring) has reached the Olympic stage as a demonstration sport in the 1988 Seoul Olympics and the 1992 Barcelona Olympics. It then became an official Olympic sport since the 2000 Sydney Olympics, followed by 2004 Athens Olympics, 2008 Beijing Olympics and 2012 London Olympics.

As in other combat sports, Taekwondo *kyorugi* has its particular scoring system. According to March, 2010 edition of the World Taekwondo Federation (WTF) rulebook, one (1) point is awarded to the player for the attack to trunk protector, either by kicks or punches; two (2) points are awarded for a valid body-turning kick to the trunk protector; while three (3) points are awarded for a successful attack to the head. Nevertheless, punching to the face is prohibited and penalty will be given upon the act (The World Taekwondo Federation [WTF], 2009; WTF, 2010a; WTF, 2010b). In October, 2010, there was an additional 4-point reward added for a valid body-turning kick to the head (WTF, 2010b).

Taekwondo matches involve many fast attacking techniques and it is impossible for an observer to record every key event in the game solely by hand notational analysis on the spot. Therefore, video/notational analysis which allows playback of the matches and 'objectifying' of the data is one of the best ways to analyze the taekwondo athletes' technical and tactical performances (Hughes & Barlett, 2008).

Performance analysis in British Taekwondo allows real-time feedback during competitions and techniques development of the athletes (Lee, 2009).

Number of studies analyzed the technical and/or tactical skills of taekwondo athletes using video/notational analysis (Wąsik & Ślęzak, 2004; Salvatore, Tessitore, Cristina, Corrado, & Laura, 2007; Giovanni, Raffaele, Stefano, Carlo, & Luigi, 2007; Matsushigue, Hartamann, & Franchini, 2009).

Most of the reviewed studies of taekwondo were conducted to compare technical and tactical skills of the winners and non-winners regardless the weight categories the athletes (Kazemi, Casella, & Perri, 2009; Kazemi, Waalwn, Morgan, & White, 2006). Kazemi et al. (2006 and 2009), and Huang and Gao (2009) also compared male and female taekwondo athletes in their studies. Giovanni et al. (2007) were on the other hand comparing the regional taekwondo athletes with the national athletes. Moreover, there was also a research on the taekwondo players in a particular weight category as in the study of Wąsik & Ślęzak (2004) who studied the female athletes in the weight category of over 70kg only, and in the study of Yang (2009) who studied the female taekwondo athletes in the weight category of 67kg and above. There were also studies (Yao & Gao, 2009; Zen, 1999) that profiled the taekwondo players' technical and tactical skills through the particular competitions.

Surprisingly, all the participants in all the reviewed studies were seniors. There was no literature focusing on the juniors or on comparing the taekwondo junior and senior players in term of taekwondo skills in the reviewed research. Only the physiological aspects as in the study of Suzana and Pieter (2009) were analyzed. This might be due to the emphasis on the seniors in the high level taekwondo championships such as the Olympic Games, Asian Games, and SEA Games although WTF conducts the World Junior Taekwondo Championships which is meant solely for the juniors aged 14 to 17 years (WTF, 2010b). This may create greater interest of the researchers to analyze the matches of junior taekwondo players. Nonetheless, taekwondo match analysis is getting increasingly popular since the *kyorugi* component of taekwondo was included in Olympic Games since 2000.

Therefore, the current study was aimed to determine the taekwondo techniques (punch and kicks) variety & efficiency and to compare between the junior and senior taekwondo players by video/notational analysis of the matches. It could give a good start to improving

the taekwondo techniques and tactics of the junior players by running the research on comparing technical variability of the junior and senior taekwondo players.

METHODS

Research Design

A quantitative, cross-sectional study was conducted during the championship of a national status in Kota Bharu (Kelantan). The championship was staged as per the World Taekwondo Federation rules, with some of the components managed as per the March, 2010 modifications, where the competition duration was adjusted by the organizers from 2 minutes x 3 rounds x 1 minute rest interval between rounds to 1.5 minutes x 3 rounds x 30 seconds rest interval between rounds (Kelantan Taekwondo Association-Universiti Sains Malaysia, 2010).

Participants

Contestants from the feather weight category (51-55 kg) from the division of WTF juniors aged 14 -17 years (n=10), and fin weight category (under 54 kg) from the senior division (n=11), in the 2nd Kelantan-Universiti Sains Malaysia (MTA/WTF) Open Taekwondo Championship (2nd KUSMOTC) running in accordance to the WTF competition rules and interpretation, were recruited for this study.

Data collection instruments

i) Handy cam (SONY, HDR_XR350E)
ii) Participants' profile questionnaire
iii) Notational analysis sheets

Procedures

Participants were given an explanation regarding the nature of the experimental procedures. Informed consent form and athlete profile form were then given to the participants to be filled in. All the competition matches of the male junior (n=10) and senior (n=11) players were video recorded by the handy cam.

The frequency and variety of taekwondo techniques were recorded by hand notational system through the replay of the video recording of the matches. Knock-out (KO) round was treated as incomplete data and sudden-death round was treated as outlier. They were then not taken into account for statistical analysis.

Statistical procedure and data analysis

SPSS 18.0 package was used to analyze the data.

1. Frequency analysis through cross-tabulation was used to determine the taekwondo techniques variety of the male juniors and seniors; and chi-square test was used to determine the statistically significant difference.
2. Independent t-test was implemented to determine the statistically significant differences of the overall taekwondo techniques efficiency of the male junior and senior groups.
3. Two-way Analysis of Variance (ANOVA) test was utilized to determine the statistically significant difference of the taekwondo technique efficiency of the male juniors and seniors across the three rounds of a match

RESULTS

Demographic data and characteristics of the taekwondo players

According to Table 1, taekwondo seniors in this study were significantly elder, more experienced in training years, but shorter in height than the juniors. Their frequency of training per week was not significantly different, though the juniors were training slightly more frequent than the seniors.

Table 1: Descriptive statistics of demographic data of the taekwondo players

Demographic data	Group		t-statistics value	*P*-value
	Seniors	Juniors		
Age (years)	20.45 ± 1.11	15.40 ± 0.37	4.330	0.001*
Height (cm)	166.28 ± 2.02	172.06 ± 1.06	-2.458	0.024*
Experience in taekwondo (years)	9.22 ± 1.10	4.70 ± 0.82	3.246	0.004*
Frequency of training per week	2.82 ± 0.42	3.20 ± 0.33	-.704	0.490

* Mean differences of demographic data between seniors and juniors are significant, $P<0.05$.

Further, all of the seniors in this study were black belt holders, while only 30% of the juniors were the black belt holders as shown in Table 2. Most of the juniors (40.00%) were red belt holders; while 20% and 10% of them were holding green and yellow belts, respectively. Chi-square test showed significant differences between the juniors and seniors in terms of their belt level ($P=0.009$).

Table 2: Distribution (expressed in percentage) of level of belt colour for the taekwondo juniors and seniors involved in the study

Level of Belt Colour	Group		Chi-square test value	*P*-value
	Seniors	Juniors		
Black	100	30	11.550	0.009*
Red	0	40		
Green	0	20		
Yellow	0	10		

* Differences of distribution (expressed in percentage) of level of belt colour between seniors and juniors are significant, $P<0.05$.

Table 3 shows no significant differences between the highest participation levels of the 2 groups (P=0.809).

Table 3: Distribution (expressed in percentage) of the highest participation level of the taekwondo juniors and seniors

Highest Participation Level	Group		Chi-square test value	*P*-value
	Seniors	Juniors		
International	37.5	33.3	0.059	0.809
National	62.5	66.7		

Preferred techniques of the taekwondo players

Two cross-tabulation tests were done to analyze the distribution of the preferred techniques used by the taekwondo players during their matches, with one analyzing the technique groups in Table 4 and the other analyzing each technique in Table 5. The grouping was done in accordance to the points scored (awarded) for the execution of the technique during a match: 1-point, 2-point and 3-point scoring techniques.

Chi-square statistics showed significant differences between the two groups in the preferred techniques used in the taekwondo matches (P<0.001). Nevertheless, no significant differences were found between them on the preferred techniques used in accordance to technique groups though juniors were using more 2-point and 3-point techniques but less 1-point techniques as compared to the seniors (P=0.597).

The top 3 techniques preferred to be used by both juniors and seniors were *dollyo chagi*, *ap dollyo chagi* and i-jung *dollyo chagi*. All of these techniques are *dollyo chagi* with different ways of delivery. Seniors were opting for the less complicated *dollyo chagi* i.e. front leg (almost equally used) and back leg (obviously more) *dollyo chagi*; while the juniors preferred the complicated one i.e. *i-jung dollyo chagi* which is a successive kick. Nevertheless, seniors were having higher efficiency in performing all these techniques (Table 5).

Table 4: Distribution (expressed in percentage) of techniques used in the taekwondo matches by the taekwondo juniors and seniors according to the groups of techniques

Group of techniques	Group		Chi-square test value	*P*-value
	Seniors	Juniors		
1-point (to torso)	86.90	85.40	1.030	0.597
2-point (body-turning to torso)	2.00	3.10		
3-point (to head)	11.10	11.50		

Naryeo chagi is the fourth most preferred technique used by both seniors and juniors. However, juniors were obviously using it more and at the same time having higher efficiency performing this technique than the seniors (Table 5).

The fifth most preferred technique used by the seniors was *sahm-jung chagi*. However, there was only little difference between seniors and juniors (seniors using it bit more frequently) in presenting this technique though this was the ninth most preferred techniques by the juniors. The juniors performed it with a higher efficiency than the seniors. On the other hand, *mireo chagi* is the fifth most preferred technique used by the juniors happened to be the tenth preferred technique by the seniors. Juniors were using it obviously more frequently than the seniors. However, both scored zero efficiency for this technique.

Jireugi was the sixth most preferred technique used by the juniors but it was not used by the seniors at all in all the matches. Nonetheless, the juniors have negative efficiency for this technique due to penalties. Back leg *olgol dollyo chagi* was on the other hand the sixth most preferred technique used by the seniors (which is the seventh most preferred technique used by the juniors). However, the juniors used it more often than the seniors and at the same time have higher efficiency in performing this technique as compared to the seniors who did not gain any point from this technique.

The seventh most preferred technique used by the seniors was *bandae dollyo chagi*, (eleventh technique preferred by juniors). Seniors were using it in the matches obviously more than the juniors. Nevertheless, both of the groups did not score when performing this technique in matches.

Table 5: Distribution (expressed in percentage) of the techniques and their efficiency (expressed in ratio of scores to attempts) used by taekwondo juniors and seniors in the studied taekwondo matches

No.	Techniques	Seniors		No.	Techniques	Juniors	
		Distribution	Efficiency			Distribution	Efficiency
1.	*Dollyo Chagi*	56.10	0.35	1.	*Dollyo Chagi*	45.80	0.24
2.	*Ap Dollyo_Chagi*	18.50	0.17	2.	*Ap Dollyo_Chagi*	17.40	0.07
3.	*Dubal Dangsang Chagi –I-Jung Dollyo Chagi*	7.10	0.47	3.	*Dubal Dangsang Chagi - I-Jung Dollyo Chagi*	8.00	0.32
4.	*Naryeo Chagi*	3.60	0.06	4.	*Naryeo Chagi*	6.30	0.19
5.	*Dubal Dangsang Chagi – Sahm-Jung Dollyo Chagi*	3.10	0.43	5.	*Mireo Chagi*	5.40	0
6.	*Olgol Dollyo Chagi*	2.40	0	6.	*Jireugi*	4.50	-0.05
7.	*Bandae Dollyo Chagi*	2.20	0	7.	*Olgol Dollyo Chagi*	3.30	0.29
8.	*Dwit Chagi*	2.00	0.22	8.	*Dwit Chagi*	3.10	0
9.	*Bandal Chagi*	1.60	0.29	9.	*Dubal Dangsang Chagi - Sahm-Jung Dollyo Chagi*	2.80	0.5
10.	*Mireo Chagi*	1.10	0	10.	*Dubal Dangsang Chagi - Sa-Jung Dollyo Chagi*	1.40	0.5
11.	*Huryeo Chagi*	0.70	0	11.	*Bandae Dollyo Chagi*	0.50	0
12.	*Ap Olgol Dollyo Chagi*	0.70	0	12.	*Bandal Chagi*	0.50	1.5
13.	*Yeop chagi*	0.40	0	13.	*Dubal dangsang chagi - oh-jung dollyo chagi*	0.20	1
14.	*Dubal dangsang chagi – sa-jung dollyo chagi*	0.20	1	14.	*Huryeo chagi*	0.20	0
15.	*Dubal dangsang chagi – ryook-jung dollyo chagi*	0.20	1	15.	*Ap olgol dollyo chagi*	0.20	0
				16.	*Dolke olgol dollyo chagi*	0.20	0
				17.	*i-jung olgol dollyo chagi*	0.20	0

***** Differences of the distribution (expressed in percentage) of the techniques between juniors and seniors are significant through chi-square test, $P<0.001$ ($P<0.05$).

Dwit chagi was the eighth most preferred technique used by both the juniors and seniors in taekwondo matches. Seniors have high efficiency in performing the technique even though juniors were using it more frequently.

The ninth most preferred technique used by the seniors was *bandal chagi* which ranked twelfth in the junior group. Although seniors performed this technique more frequently than the juniors, but the latter have much higher efficiency than the seniors in performing it.
The juniors are doing more *sa-jung dollyo chagi* as compared to the seniors. Nevertheless, seniors performed it with a higher efficiency.

Seniors used more *huryeo chagi* and *ap olgol dollyo chagi* than the juniors but they both ended up by scoring zero.

Oh-jung dollyo chagi, *i-jung olgol dollyo chagi* and *dolke olgol dollyo chagi* were used occasionally by the juniors in all the matches but the seniors did not use these techniques at all. The juniors have high efficiency in performing *oh-jung dollyo chagi* though they did not score by using *i-jung olgol dollyo chagi* and *dolke olgol dollyo chagi* in the matches. On the other hand, *yeop chagi* and *ryook-jung dollyo chagi* were used occasionally by the seniors though they did not score from the techniques but these 2 techniques were not at all used by the juniors in the matches.

There was a significant difference between the seniors and juniors on the overall techniques efficiency from independent t-test (Table 6) where seniors were having higher overall techniques efficiency than the juniors (P<0.001).

Table 6: Overall attacking techniques efficiency (ratio of scores to attempts of techniques used) between taekwondo juniors and seniors

Group	**Overall Techniques efficiency (mean ± standard deviation)**	**t-statistics value**	***P*-value**
Seniors	0.29 ± 0.13	9.080	< 0.001*
Juniors	0.20 ± 0.16		

* Mean difference of techniques efficiency between juniors and seniors is significant, P<0.05.

Table 7 shows the two-way ANOVA test results of the techniques' efficiency of seniors and juniors across the 3 rounds of the taekwondo matches. Significant interactions were found between the 3 rounds and the 2 groups (P<0.001). Besides, significant main effects were also found for the repeated measure 'round' i.e. the 3 rounds of a taekwondo match and the 'group' i.e. junior and senior groups (P<0.001). The locations of the main effect for 'round' are at the pairs of rounds 1 and 2, as well as rounds 1 and 3 (P<0.001) but not the pair of rounds 2 and 3 (P=0.158), which indicated that the significant differences of techniques efficiency were only found between round 1 and 2 as well as rounds 1 and 3 but not between rounds 2 and 3. Then, locations of the simple main effect of the groups on the rounds of match were found in round 2 and round 3 (P<0.001) but not in round 1 (P=0.158) which indicated that juniors and seniors techniques efficiencies were significantly different only in round 2 and 3 but not in round 1.

Overall frequency of techniques used by both the juniors and seniors in this study were 261, 315, and 299 in the first, second, and third rounds, respectively. Seniors' frequencies of techniques application were 142, 160, and 147 in the first, second, and third rounds,

respectively. On the other hand, juniors' frequencies of techniques application were 119, 155, and 152 in the rounds 1, 2 and 3, respectively (Figure 1). As an overall, both of the junior and senior groups used the least techniques in round 1, the most in the second round and moderate in the final round which can be seen. The trend was the same even when we look at the techniques frequency of the 2 groups across rounds separately.

They both applied the least numbers of techniques in the first round yet having high techniques efficiency in that round. Nevertheless, seniors had higher techniques efficiency than the juniors in the final round (in fact the highest techniques efficiency found in the match) as shown in Figure 2.

Table 7: Attacking techniques efficiency (ratio of scores to attempts of techniques used) between taekwondo juniors and seniors according to rounds

Round	Techniques efficiency (mean ± standard deviation)			ANOVA test p-value		
	Group		Overall	Main effect for the repeated measure 'round'	Interaction between round & group	Main effect for the 'group'
	Seniors	Juniors				
1	0.29 ± 0.13	0.28 ± 0.22	0.29 ± 0.18∞,£	*P*<0.001*	*P*<0.001*	*P*<0.001*
2	0.27 ± 0.12#	0.16 ± 0.19#	0.25 ± 0.17∞			
3	0.30 ± 0.17¥	0.15 ± 0.13¥	0.23 ± 0.17£			

* There are significant main effects for the 3 rounds and the 2 groups, and significant interactions between the round and group, $P<0.05$.
∞ & £ Locations of the main effect for 'round', namely pairs of rounds 1 & 2, and rounds 1 & 3, $P<0.001$ ($P<0.05$); but not the pair of rounds 2 & 3, $P=0.158$ ($P>0.05$).
& ¥ Locations of the simple main effect of the groups on the rounds of match, namely round 2 and round 3, $P<0.001$ ($P<0.05$); but there is no simple main effect in round 1, $P=0.920$ ($P>0.05$).

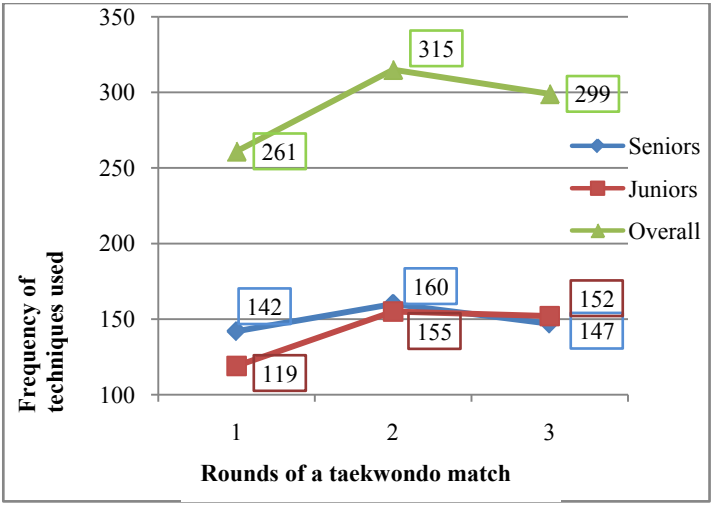

Figure 1: Techniques frequency group wise and both groups combined across the 3 rounds of the taekwondo match

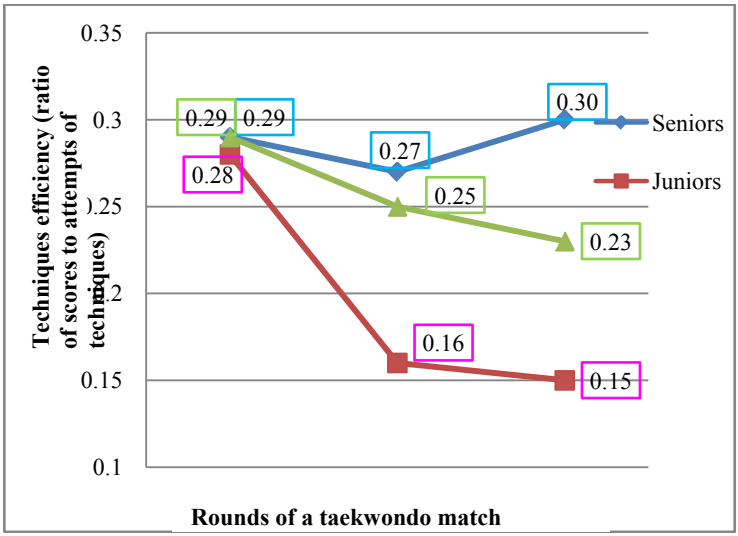

Figure 2: Techniques efficiency group wise and both groups combined across the 3 rounds of the taekwondo match

DISCUSSION

In this study, there were altogether 19 taekwondo techniques used by the taekwondo players. In detail, seniors were using 15 techniques whereas juniors used 17 techniques. *Jireugi*, *oh-jung dollyo chagi* (a type of *dubal dangsang chagi*), *dolke olgol dollyo chagi*, and *i-jung olgol dollyo chagi* were not used by the seniors in the matches; while *ryook-jung dollyo chagi* (another type of *dubal dangsang chagi*) and *yeop chagi* were not used by the juniors.

Overall in the taekwondo matches of the seniors and juniors analysed, *jireugi* (a punch) was used only 2.25% while the rest of the 97.75% techniques used were the different types of kicks which is similar to the study of Kazemi et al. (2006) who stated that 98% of all techniques used to score were kicks.

A punch is not commonly used to score as a kick, especially in WTF taekwondo championships. This may occur because legs are always more powerful than arms in producing impact to the target and in turn, to score. This may be explained by citing the concept of angular momentum which is the product of total body mass, the square of radius of gyration and angular velocity (Hall, 2006). Therefore, legs which are heavier and longer will produce greater moment of inertia and then produce greater momentum that promotes a higher impact. Besides, using punch increases the risk of getting penalties due to the rule that forbids the punch to face. This can be proven when the juniors in this study used punch but ended up by obtaining negative technique efficiency for this technique as shown in Table 7, resulted from the penalty of punching to the opponents' face. Seniors who are more experienced tend to minimize the use of punch in competition, just as the seniors in this study did not use this technique at all. Giovanni et al. (2007) suggested that the taekwondo athletes should use less punching techniques as the regional athletes in their study used more punch than the national athletes yet they were less successful than the national athletes. Nevertheless, *jireugi* could be used as part of the tactics in taekwondo match e.g. taekwondo athletes could use a punch to push the opponents away and continue with kicks when the opponents are losing balance.

Dolke olgol dollyo chagi and *i-jung olgol dollyo chagi* are both kicking techniques to the head and they are considered advanced kicks as they involve 360°-turning of the body and continuous movement, respectively. It makes sense when the significantly taller juniors with higher centre of gravity in this study used these techniques in the taekwondo matches but not the seniors. However, since those are advanced kicks and the juniors might not be skillful in performing them, they ended up by getting zero efficiency for these 2 techniques. It was good to see that the juniors were not using *yeop chagi* in the matches at all, as Yao and Gao (2009) reported in his study that *yeop chagi* reduced the proportion for scores while other techniques increased that possibility, which indicated that it was not a good technique to score in taekwondo matches. However, it was a surprise to find out that this reasonably simple kick was used by the seniors and they finally ended up by getting zero efficiency in this technique. This technique may be used as part of the tactics in taekwondo match but not to score.

The two groups were performing equally good (techniques efficiency = 1 as shown in Table 5) techniques of *oh-jung dollyo chagi* by the juniors and *ryook-jung dollyo chagi* by the seniors. This indicated that taekwondo players in this study scored more easily by continuous kicks.

Among the 3 groups of techniques, namely the 1-point, 2-point and 3-point techniques, both groups of the taekwondo players used the 1-point techniques the most in the taekwondo matches. Giovanni et al. (2007) reported that regional athletes in his study scored more frequently and more easily through kicks to the body than national athletes. Surprisingly, the second most used techniques were of the 3-point techniques and this was only then followed by the 2-point technique. This may be due to the relative difficulty in performing the 2-point technique which involves the turning of the players' body for at least a 180° as compared to kicking to the head.

Although the differences were not significant, juniors were generally doing less 1-point techniques and more 2- and 3-point techniques than the seniors. Seniors who used more 1-point techniques during the matches were at the same time having higher average 1-point techniques efficiency which was 0.34 as compared to the juniors with 0.26. On the other hand, juniors used more 3-point techniques and had greater 3-point techniques efficiency (0.25 as compared to the seniors' 0.04). Nevertheless, seniors who used less 2-point technique, *dwit chagi* in this case, have better 2-point technique efficiency i.e. 0.22 than the juniors who did not score for the technique. The wide use of 1-point techniques by both groups may occur because it is relatively easier to perform than the 2- and 3-point techniques also allowing the players to recover faster from the performed 1-point technique to make another follow-up kick, as well minimizing the opportunity for their opponents to counter-attack. Next, Yao and Gao (2009) reported in their study that head-hit techniques (the 3-point techniques) are commonly used in match by the male taekwondo Olympians, which shows that the juniors in this study are properly trained and in the long run may one day reach the skills variety similar to the one with Olympians.

Despite the insignificant differences in groups of techniques used between juniors and seniors in this study, there were significant differences of every technique used between the juniors and seniors. The most preferred technique used by both the juniors and seniors was *dollyo chagi* performed by posterior lower limb. It is a horizontal kick. The trend of favoritism of using *dollyo chagi* by athletes in taekwondo match is confirmed by the studies of Yang (2009), Huang and Gao (2009). Even Wąsik and Ślęzak (2004) who reported that *jireugi* was the most widely used technique by the above 70kg female taekwondo athletes also reported that *dollyo chagi* was the most used kicking technique. *Dollyo chagi* is a very popular kick in *kyorugi* which may be because of its high power and speed (Pawlett & Pawlett, 2004). Besides, it is among the simplest kicks, in which the taekwondo trainees have to learn when they are at the white belt level (The Malaysia Taekwondo Association [MTA], 2001). It is then widely practiced and it may become a habit for a taekwondo athlete to use this technique in a match. The seniors were using this technique 5% more than the juniors and their technique efficiency was 0.05 more than the one of juniors.

The next preferred technique used by both juniors and seniors was *dollyo chagi* performed by using the anterior lower limb, the *ap dollyo chagi*. Salvatore et al. (2007) reported that there was a significantly (P<0.001) higher involvement of the posterior lower limb for both winners and losers than the anterior one. Techniques performed by the anterior lower limb may be faster than the posterior one due to its shorter distance to the target but they are normally less powerful as compared to the posterior one. This may be explained by using the angular momentum concept. Therefore, *dollyo chagi* which is performed by the posterior limb is more powerful due to its greater radius of gyration. As the technique of

back leg *dollyo chagi*, seniors have 0.10 better *ap dollyo chagi* efficiency than that of the juniors.

Seniors in this study were generally better in performing *dubal dangsang chagi* (the continuous kick), as well as *dwit chagi*. This could be seen when they were doing 1.8% of *dubal dangsang chagi* less than the juniors yet the average efficiency of the 5 techniques of *dubal dangsang chagi* was 0.12 more than the juniors; and 1.1% of *dwit chagi* less than the juniors yet the technique efficiency was 0.22 higher than that of the juniors. The juniors of this study did not score at all in doing *dwit chagi*. The seniors were weaker only in doing the *sahm-jung dollyo chagi* than the juniors but not *i-jung dollyo chagi* and *sa-jung dollyo chagi*. Distance, speed and correct techniques of performing the techniques are very much important for the accuracy of the continuous kicks or the energy of the athletes would be wasted by ending up with zero scoring. Performing good body-turning technique like *dwit chagi* requires a good skill of the athletes, too. They need to judge the distance from the opponents, position of the opponents while turning their body (most of the time not looking at the opponents) to make a back kick. It is considered a complex technique and will be learnt by the taekwondo practitioners only when they reached green belt level. Since there were 20% and 10% of juniors in this study holding green and yellow belts, respectively, it is reasonable to assume that the their skills are not as good as the seniors' who were more experienced to perform the continuous kicks as well as the body-turning kick.

However, seniors in this study were generally weaker than the juniors in performing the 3-point techniques. They both were doing the techniques quite equally with juniors doing a little bit more frequently than the seniors. The juniors have better average efficiency of the 3-point techniques i.e., 0.21 better than the seniors. They were especially good in performing *bandal chagi*, *olgol dollyo chagi* and *naryeo chagi* while the seniors were far weaker. *Bandal chagi* is the only highest efficient technique used in the matches with a technique efficiency of 1.50. The most reasonable explanation for the most utilization of 3-point techniques by the juniors is that the juniors are significantly taller than the seniors, though training they have been through could be a reason as well.

Seniors who are more experienced in taekwondo competitions used less *mireo chagi* as compared to the juniors. In fact, *mireo chagi* is not usually a scoring technique, but is normally used as part of the tactics to push the opponent away and subsequently use other attacking techniques when the opponent is out of balance which will help the taekwondo players to score easier. To a lesser extent, it enables the players to obtain point if it is being executed powerfully and accurately.

Bandae dollyo chagi is considered one of the most advanced kick which will be learnt mostly when a taekwondo practitioner got their red belt. It is not at all an easy technique to perform because even the seniors in this study who are supposed to be more skillful and more experienced ended up scoring zero though they were doing it more than the juniors did.

Since the juniors were only better than the seniors in performing the 3-point techniques, the overall techniques efficiency of the seniors was still significantly better than that of the juniors. The seniors in this study indeed performed the 1- and 2-point techniques well, especially the 2-point techniques, particularly *dwit chagi*. Overall technique efficiency of the juniors may also be reduced due to the negative efficiency while performing *jireugi*.

As an overall, the combined techniques efficiency of the 2 groups of the taekwondo athletes in this study was reducing from the first round to the third round of a match. However, significant mean techniques efficiency difference occurred only between the pairs of rounds 1 and 2, as well as round 1 and 3. Despite there was small difference on the techniques efficiency between the pair of rounds 2 and 3, the difference was not significant.

It needs to be mentioned, that the results obtained regarding the throughout the match techniques efficiency could be influenced by the competition format in this study i.e. 3 rounds of 1.5 minutes each, with a 30 seconds rest period between the rounds. However, when we analyze the match more in-depth, taekwondo athletes are not all the time kicking and punching continuously in any round of the match; they jog, play with foot-work, and flick their opponents before the real attack. All these actions are normally not as intensive as the real attack and thus aerobic energy system may be responsible for the energy supply for these less intensive actions just as Matsushigue, et al. (2009) suggested in their study. Since the intensive taekwondo techniques are usually performed in no longer than 10 seconds the phosphagen system where phosphocreatine (PC) is used to replenish the limited adenosine triphosphate (ATP) stores in the working muscles for around 10 seconds (McArdle, Katch, & Katch, 2000) is responsible for the energy supply as suggested in the study of Matsushigue, et al. (2009). Then, resting of 30 seconds between the rounds will help athletes to replenish the PC up to 70 % (Bompa, 1994). Therefore, the athletes should not be extremely fatigued across the rounds and techniques efficiency should not deteriorate a lot. This trend could be seen in the seniors in this study who scored well in the first round though the techniques efficiency dropped in the second round but they managed to score the best among the 3 rounds in the final round. Besides, techniques efficiency across the 3 rounds was quite stable and without drastic change. However, this could not be seen in juniors whose techniques efficiency kept reducing across the rounds. This may be due to the poor fitness when compared to the seniors. This may subsequently cause muscular fatigue and could impair their performance by reducing their techniques efficiency.

Findings on techniques frequency in round one are similar to the study of Kazemi, et al. (2006) that reported that both male winners and non-winners had the highest percentage of scoring in round 1. This fighting pattern may indicate that the athletes were fresh and energetic in the first round and this might be one of their strategies to score as many points as they could in the first round so that less work-demand will be placed on them in the next 2 rounds where fatigue may come into place.

Further, although both groups were having the highest frequency of techniques in the second round, they both actually ended up scoring the least in that round. In the third round when fatigue was more prominent, they both used fewer techniques than in the second round but still, it was higher than the first round. This finding is similar to the study of Huang and Gao (2009) that reported that both male and female taekwondo athletes have the fewest kick strikes in the first round and the most in the third round of match, and the study of Salvatore et al. (2007) who reported that the winners perform more kicks for attacking actions, during the second and third rounds with respect to the first one. This may be due to their determination for winning the match by striving for as many points as possible in the last round. Seniors in this study managed to earn points through this final determination by achieving the highest techniques efficiency among the 3 rounds. Nevertheless, the juniors could not perform in the final round as their techniques efficiency reduced to the least in the final round though they were actually trying hard to earn points by attempting more techniques.

On the other hand, Kazemi, et al. (2006) reported in his study that the female winners scored the least in round 1 in contrast to female non-winners. Rather, they scored more than half of their total points in Round 2. We could actually notice that the trends of techniques efficiency across rounds among the taekwondo athletes are pretty inconsistent which might be a result of the different strategies used by different groups of athletes, provided when fatigue was not the major issue.

Both groups achieved relatively low techniques efficiency even with the highest techniques frequency among the 3 rounds in the second round. Besides, in the third round, juniors who tried more by using more techniques, actually scored much less than the seniors who did less work. These facts show that high volume of techniques used would not guarantee high techniques efficiency. However, it is the quality of the techniques being performed of importance to help the athletes to obtain scores as suggested by Matsushigue, et al. (2009).

CONCLUSION

The senior taekwondo athletes in this study have had greater overall techniques efficiency as compared to the junior players. They were especially better than the juniors in performing *dubal dangsang chagi* (the continuous 1-point technique), and *dwit chagi* (a 2-point technique).

However, juniors were performing the head-hit techniques (3-point technique) much better than their senior counterparts. It was a good start for the juniors to achieve to the top as Yao & Gao (2009) once reported that head-hit techniques were commonly used during the match by the male taekwondo Olympians.

Punch was used by the juniors but with negative technique efficiency. It was not at all used by the seniors.

Although there was no significant mean difference between juniors and seniors in terms of their training frequency per week, the juniors are actually training more than the seniors. Nonetheless, they still demonstrated weaker techniques efficiency than the seniors. Therefore, juniors might be advised to improve their skills in performing:

1. 1-point techniques especially the continuous kicks since they allow easier scoring; and
2. 2-points techniques in order to be as good as the seniors in term of technical efficiency

Besides, they should continue working on their 3-point techniques so that the techniques efficiency could be increased to stand a chance to be as technically sound as the Olympians. Other than that, they should practice various punching techniques so that they can do it in a proper way, accurately and powerfully or they should actually limit the use of those during competition due to the high risk of obtaining penalty from using it as we can see in this study. It is also not energy-economic to perform an action inaccurately that will produce zero score. Nevertheless, coaches can incorporate punches to be part of the tactics in taekwondo match e.g. as the initiation or a fake technique to distract the opponents and continue with the real attack, e.g. a punch which is followed by a continuous kick like *i-jung dollyo chagi*. Biomechanics and coaching science are then playing a crucial role in developing and polishing the punching techniques of the juniors.

Fatigue pattern wise, the seniors were better handling themselves across rounds. Their techniques efficiency was not decreasing like the juniors' but they manage to achieve the highest techniques efficiency in the final round. Nevertheless, both groups were weak in the second round of the match where they attacked most but ended up scoring low. Coaches have to plan a training program that will improve both ATP-CP (which is important while performing the short high-intensity techniques) and aerobic energy systems (which is important in between the high-intensity techniques and in sustaining high match pace and efficiency) of the athletes so that they could perform equally efficient in the 3 rounds. This is especially important for the juniors who might soon transit to the senior group yet having significantly poorer techniques efficiency than the seniors as well as experiencing decrease performance efficiency across rounds.

ACKOWLEDGEMENTS

We would like to thank the organizer of 2nd KUSMOTC for their cooperation when the research was being carried out. We would also like to thank the volunteers who helped in the data collection.

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Student- Athletes' Perceptions of Coaches' Coaching Competency at the Malaysia Public Institution of Higher Learning

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Abstract

Coaching is a complex task and requires the use of different strategies and behaviors to fulfill many expectations. Sports coaches have to possess good knowledge, skills and high motivation in carrying out responsibilities to produce quality athletes. However, there is a lack of research conducted on coaches' coaching competency in the Public Institution of Higher Learning (IPTA) on whether the coaches possess good competency in order to produce potential athletes for the country. Thus, this study was designed to evaluate student-athletes' perception of the coaches' competency level. Multi-dimensional model of leadership behaviors and models of coaching effectiveness were used as the basis for the theoretical framework. A total of 322 student-athletes participating in the 2010 Universities Sports Council of Malaysia (MASUM) competition participated in this study. The sample consisted of 183 (57.2%) male and 137 (44.8%) female. Coaching Competency Scale (CCS) (Myers, et al, 2006) which consisted of a 24-item questionnaire was utilized for data collection process. CCS focusing on four specific categories: Character Building Competency (CBC), Game Strategy Competency (GSC), Motivation Competency (MC), and Technique Competency (TC). The results of this study indicate that the coaches' competency level at the IPTA were not significantly different between gender (male and female) and athletes' performance (winning and losing). But there was a significantdifference in athletes' perception of coaches' competency in terms of the type of sport, between team and individual sports. The information from this study may help coaches in planning strategies for coaching athletes to ensure the effectiveness of their role as a coach.

INTRODUCTION

Coaching is a complex task and requires the use of different strategies and behaviors to fulfill many expectations. Sports coaches have to possess good knowledge, skills and high motivation in carrying out responsibilities to produce quality athletes. It has been shown that behaviors of a coach may determine his competency in designing effective training hence influence achievement among his athletes (Kuga, 1993, Myers, Feltz, Maier, Wolfe & Reckase, 2006). As a matter of fact, a competent coach that gives high satisfaction to his/her athletes may motivate them to perform confidently in their games. Thus, the type of leadership behavior portrayed by the coach can have a significant effect on performance and psychological well-being of athletes (Horn, 2002). The context of the sport situation and the characteristics of the coach and the athletes themselves prescribe appropriate leadership behavior. Consequently, effective coaching behavior varies across specific contexts as the characteristics of the athletes and the prescribed situation change (Chelladurai, 1990). Hersey and Blanchard (1977) discovered that coaches' leadership may change to assimilate with environments. These environments are often explained by total of given order (task behavior), emotional support (relationship behavior) and level of maturity. Therefore, a competent coach should possess some skills in choosing the right approach, technique and tune of language when approaching their athletes.

The term "competency" refers to the knowledge, skills and performance abilities required to perform a job effectively. Some may also refer to competency as motives, traits, skills and abilities (Dalton, 1997). Thus, the concerns on coaching competency among sports coaches are common in high achieving sports countries such as Germany, United States and Australia. In Asia countries, China, Japan and South Korea are good examples due to their accelerated achievement in world class competitions. Interestingly, these countries have minimum dependencies on foreign expertise in producing world class athletes.

Malaysia possesses some world class athletes especially in badminton, diving, squash and cycling but they face some difficulties to maintain such reputable position due to (i) lack of replacement athletes, (ii) incompetence coaches and (iii) internal issues arose in the sports body. Some local studies have reported that the quality of coaching or training in Malaysia is less encouraging (Rahim Harun, 1992; Khoo Kay Kim, 1991, 1994, 1995). The former national coach for hockey team, Terry Walsh (1988), claimed that Malaysia is left behind in promoting scientific knowledge in sports thus unable to provide new techniques in coaching systems. A serious concern was highlighted by Han Peter Thumm in the local newspaper, Berita Harian on 28 December 1990, that local coaches are incompetent to train sportsmen at states and country levels. The notion was further supported by Sieh Kok Chi, the Olympic Council of Malaysia secretary, by stressing that the shortcomings of Malaysian sports was partly due to incompetent coaches, and thus, Malaysia should start with training the respective coaches first to bring back the sports culture in Malaysia (Star, September 19, 2004).

To react with such comments, students' involvement in sports has been given serious attention in Malaysia where sport involvement is taken into account in acceptance into the local higher education institutions. In fact, annual sport competition among higher education institutions is organized to support the supply of talented athletes for the country. In connection to this, it is common for higher education institutions to employ coaches to prepare institution's team for the tournaments. However, little is known with regard to the

level of competency these whether these universities' coaches possess adequate level of competency to mould potential athletes for the country?

While the coach is constantly making evaluations about his/her athletes, student-athletes are also formulating assessments about their coach's personality and behaviors. These perceptions of coaching competency could alter the performance of the student-athletes and could offer important insights into valuable information needed to improve this relationship (Cratty, 1989). In addition, it seems appropriate to consider the perspectives of student-athletes when evaluating coaching performance. Particularly important is the notion of conducting a broad comprehensive evaluation which will elicit an accurate profile of an individual's performance (Adams, 1979). However, very limited research has been conducted on coaches' coaching competency in the Public Institution of Higher Learning (IPTA) in Malaysia. Thus, the main purpose of this study is to evaluate the coaching competency of coaches at 2010 IPTA sport competition from the perspective of the student-athletes.

Research Questions

The specific research questions addressed in this study included the following:
a) What are student-athletes perceptions of coach's coaching competency based on their gender differences, sport categories (individual/team), and performance (win/loss) at 2010 IPTA sport competition?
b) Are there different levels of competency in accordance with the perceptions of student-athletes?
c) Does the performance of student-athletes influence by length of experience under supervision of their coaches?

REVIEW OF LITERATURE

The role of coaching in sports is important to ensure quality athletes in competition. Philips (2007) and Paling (2004) concluded that coaches play various roles in their profession. For example, coaches are asked to be teachers, organizers, motivators, leaders, and counselors. Williams, Jerome, Kenow, Rogers and Sartain (2003) stressed that coaches play an important role in ensuring the quality and the effectiveness of any sports program. However, the most important role of a coach is to help athletes to improve their athletic skills in a wide range of tasks from sequential development and mastery of basic skills for beginners, to the more specialized physical, technical, tactical, and psychological preparation of elite athletes (Bompa, 1999; Martens, 1987). These functions are normally accomplished by the coach that a practice leadership behavior that effectively elicits appropriate actions from the athletes towards achieving set goals, in competitive or practice situations.

Coaching competency is a source of competitive advantage in any sports. It is a complex task that needs specific strategies and behavior to fulfill certain expectations. Coaching competency consists of various variables. Previous literatures have identified the relationship between coaching efficacy and coaching perceptions (Manning, 2007). Coaching efficacy can be regarded as the extent of beliefs among coaches on how it will affect learning and performance of athletes. Coaches need to have the ability and confident in aligning game strategies and athlete's strength with the aim of coordinating the team's

strategy with the opponent's strengths and weaknesses. Four dimensions have been elaborated by Fung (2002) regarding coaching efficacy; motivation, strategy, technique and personality building.

As far as coaching competency is concerned, Myers et al. (2006) stated that there were three competency domains including (a) growth, development and learning of athlete, (b) psychological aspects of coaching, and (c) skills, tactics, and strategies. Thus, Myers et al. (2006) designed The Coaching Competency Scale (CCS) based upon these competencies. The specific competencies measured by the CCS included: character building competency (CBC), game strategy competency (GSC), motivation competency (MC), and technique competency (TC). The CCS had been validated and tested for reliability in their research on athletes' evaluation of their head coach's coaching competency and found to be psychometrically sound.

In addition, according to Myer et al. (2006), many instruments are designed to measure a coach's behavior. However, three instruments that are most prominent are the Coaching Behavior Assessment System (Smith, Smoll, & Hunt, 1977), the Leadership Scale for Sports (Chelladurai & Saleh, 1978, 1980), and a Decision Style Questionnaire (Chelladurai & Arnot, 1985). Indeed, these instruments have also been used to assess athletes' perceptions of their coach's behavior (Horn, 2002).

In relation to coaches' leadership behavior, Chelladurai and Saleh (1978) reported that team sport athletes preference for training and instruction leadership style was significantly greater than that of individual sport athletes. Closed-sport (low-variability tasks) athletes also preferred significantly more training and instruction than did the open-sport athletes (high variability tasks). Terry and Howe (1984) found that athletes in independent sports (team sports) preferred more democratic and less autocratic behavior than did the athletes in interdependent sports. Another study by Terry (1984) reported that team sport athletes preferred significantly more training and instruction, autocratic behavior, and positive feedback, but less democratic behavior and social support than individual sport athletes. Besides, Schliesman (1987) has done a study on coaching leadership in individual sports. The purpose was to determine leadership behavior in sports and establishing the relationship between satisfaction and leadership among athletes. It was found that both democratic behavior and social support has a significant relationship. The higher the democratic behavior shown by coaches, the more social support the athletes will acquire. Even though the methodological aspect of the mentioned study was questionable especially on sample selection, the finding has provided insights on coaches' behavior. Furthermore, these results lend support to path-goal theory (House, 1971), which postulates that when tasks are varied and interdependence, greater structure and closer supervision will be preferred.

In addition, the influence of athletes' gender has been tested across a wide-range of team and individual sports (Chelladurai & Arnott, 1985; Chelladurai & Saleh, 1978; Terry, 1984; Terry & Howe, 1984; Lim 1995). However, in general, the degree of similarities or differences between genders in their coaching preferences is unclear and required further investigation. For instance, Terry and Howe (1984) investigated the coaching preferences 160 athletes (male = 80; female = 80) from 16 sports. The researchers found considerable similarities between genders. The findings indicated that preference scores of the male athletes were significantly higher than those of the females athletes for autocratic only.

Similarly, Terry (1984) investigated the coaching preferences of elite male and female intercollegiate athletes participating in a number of dual-gender sports, including basketball, volleyball, track and field and swimming. The results indicated that male athletes prefer more autocratic behavior than female athletes. This partially support Chelladurai and Saleh's (1978) findings that male athletes prefer more autocratic and social support behavior and female athletes prefer more democratic behavior.

Limited research exist on coaching behaviour in the Malaysian contexts. One study, which was conducted by Lim (1995) explored the coaching behavior and their relationships with achievement motivation and satisfaction among athlete in secondary schools. By adapting the Leadership Scale for Sports (Chelladurai & Saleh, 1978, 1980) for data collection, the results indicated that the training and instruction, and rewarding behavior are often exhibited by the coaches. Moreover, autocratic behavior is seldom portrayed. From the perception of athletes, the findings indicated significant difference between men and women's perceptions on autocratic and social support behaviors. Male athletes seem to perceive their coaches portrayed more autocratic behavior and female athletes perceived their coaches exhibited more social support behavior. These findings are consistent with the previous studies such as by Chelladurai and Saleh, (1978), Terry (1984) and Terry and Howe (1984). Additionally, field games athletes (e.g. football, netball, softball) perceived their coaches portrayed more training and instruction behavior compared to court games athletes (e.g. volleyball, basketball).

However, a study by Abdul Hafidz and Norazman (2004) regarding the relationship between coaches' profile and athletes' performance showed that coaches' skills not only help athletes in enhancing their physical, technical and psychological ability, but also educate athletes in their social and spiritual life. A qualitative approach (interview, document analysis and observation) was employed to compile data on coaches' profile, training program and athlete's achievement. The outcome of the study revealed that experience and qualification in coaching is imperative as determining factor towards athletes' performance either in individual or team sports. However, there were contradicting perceptions and views between coaches and managers that result in poor performance of the athletes. Coaching style should be tailored based on situational factor in order to secure success in sports. Coaches' individual philosophy, work ethics and professionalism with proper communication style will contribute significantly to the success in any sports and competition.

METHOD

Research Design

This study was conducted with the aim to obtain empirical evidence about competency of coaches of higher education institutions in Malaysia. Specifically, it focused on student-athletes perceptions of the competency of their coaches at 2010 IPTA sports competition. A quantitative approach by using field survey method was used in this study. Students from four public universities in the northern peninsular of Malaysia were included in the sample selection.

Subjects

A total of 322 student-athletes were chosen via purposive sampling technique as the subjects. They were identified by an athletic administrator of their respective universities representing various sports, including team and individual sports

Instrumentation

The instrument selected for the study was the Coaching Competency Scale (CCS) developed by Myers et al. (2006). The 24-item questionnaire in CCS was designed to measure four different dimensions. The four categories included motivation competency (MC), game strategy competency (GSC), techniques competency (TC), and character building competency (CBC). The definition of each dimension is given in Table 1. All items are measured using a Likert scale of 10 points where (1) indicates "not at all competent" and (10) indicates "extremely competent". Following Myers et al. (2006) this study identifies the level of competency on coaches based on the overall student-athletes perception score of the items. Competency is defined by Myers et al. (2006) as, "athletes' evaluations of their coach's ability to affect athletes' learning and performance" (p.452).The questionnaire was prepared in Malay (Malaysia national language), hence the translation processes of CCS which originally in English were performed via back translation (Brislin, 1971). Then, we conduct a pilot test on the designed questionnaire to 290 respondents to evaluate reliability of the questionnaire. The results of this pilot test showed that the instrument's reliability based on Cronbach's Alpha is a little bit higher than the ones reported by Myers et al. (2006) (see Table 2). Such findings allow us to use the translated questionnaire for actual study.

Table 1: Definition of five dimensions of coaches' coaching competency

Dimension of competency	Definition
Motivation	Coaches' ability to affect mood psychology and skills of athletes.
Game strategy	Coaches' ability to lead athletes during competition.
Techniques	Coaches' ability to make some diagnostics and giving instructions to athletes.
Character building	Coaches' ability to influence athletes' personal development and positive attitude towards sports.

Table 2: Internal consistency of CCS

Dimension of competency	Cronbach's Alpha Value	
	Pilot study *(n = 290)*	Past literature
Motivation	0.9565	Myers et el.(2006): Range from 0.82 to 0.92 for each dimension of competency
Games strategy	0.9467	
Techniques	0.9419	
Character building	0.9149	
Total coaching	0.9844	

Procedures

Permission to collect data with undergraduate students was received from the selected university administrators. Questionnaires were administered by two trained research assistants as well as via the sport officers from the subjects' respective universities. For cost related reasons, we limited the sample to the four universities located in northern peninsular of Malaysia namely Perlis, Kedah and Penang. The subjects were asked to complete a survey questionnaire. They were informed concerning the purpose of the study and general instructions were provided, help was offered when needed, and responses were anonymous.

Data Analysis

The questionnaires collected were processed and analysed with the SPSS/PC 16.0 statistical software package. The descriptive statistics were used to examine the means and standard deviations of each dimension of coaching competency according to gender, type of sports, and performance. *T*-test was performed to compare means differences between each group. Line graph was also plotted to present the relationship between the student-athletes' performance (win vs. loss) and the length of experience with their coach's supervision.

RESULTS AND DISCUSSION

Background of sample

The analysis on 322 samples of student-athletes showed that 57.20% were male and 42.80% were female. 60.25% of them involved in team sports, which comprises of at least two players in a team, and the remaining were in individual sports such as swimming, archery and golf. Since the study was conducted among student-athletes in universities, therefore 59.25% of our samples have their experience at most 12 months with their respective coaches. The obtained samples also indicate that 55% of them won the game that they had participating (winner, first runner up or second runner up) and 45% defeated.

Coaches' coaching competency

Research questions (a) and (b) asked "What are student-athletes perceptions of coach's coaching competency based on their gender differences, sport categories (individual/team), and performance (win/loss) at 2010 IPTA sports competition?" And "Are there different levels of competency in accordance with the perceptions of student-athletes?" Descriptive statistics were used to quantify each student-athletes' responses to the CCS. The mean values for each dimension according to each category are presented in Tables 3, 4, and 5. The investigators computed the average of total of competency and compared the groups of each factor statistically. The summaries the results are also tabulated in Tables 3, 4 and 5.

Competencies of coaches from gender point of views show that both male and female athletes rated their coaches with average total score close to the maximum score. This implies that the athletes find their coaches as possessing adequate level of knowledge, skills and experience in motivating, planning for strategy, imposing good techniques and building good characters for them. The results also show that the scores from both genders are not much difference. To confirm this, a statistical test was conducted on each dimension as displayed in the last column of Tables 3, 4, and 5. The result on each dimension shows that

there is no significantly different of perceptions between genders hence gender is not a criterion that can distinguish level of competency among coaches. Based on these findings, we can also justify that coaches are not showing any signal of gender biased in training their athletes. They perhaps giving them exercises and coaching them suitable with their energy and physical.

Table 3: Student-athletes perceptions on coaching competency in terms of gender

Dimension of Competency	Num. of items	Min. score	Max. score	Factors				Test differences between groups
				Gender				
				Male		Female		
				M	*SD*	*M*	*SD*	
Motivation	7	7	70	55.89	10.44	56.83	10.27	t = -0.796 (p = 0.427)
Games strategy	7	7	70	55.71	10.54	55.51	8.54	t = 0.182 (p = 0.856)
Techniques	6	6	60	48.06	9.04	47.82	7.30	t = 0.247 (p = 0.805)
Character building	4	4	40	31.93	6.12	32.47	4.62	t = -0.847 (p = 0.397)
Total coaching	24	24	240	192.410	35.138	192.258	28.198	t = 0.041 (p = 0.967)

Table 4: Student-athletes perceptions on coaching competency in terms of types of sports

Dimension of Competency	Num. of items	Min. score	Max. score	Types of sports				Test differences between groups
				Individual		Team		
				M	*SD*	*M*	*SD*	
Motivation	7	7	70	57.11	8.76	54.80	12.52	t = 1.930 (p = 0.55)
Games strategy	7	7	70	56.73	9.11	53.73	10.58	t= 2.680** (p = 0.008)
Techniques	6	6	60	48.74	7.62	46.54	9.40	t = 2.269* (p = 0.024)
Character building	4	4	40	32.61	5.21	31.35	6.05	t = 1.977* (p = 0.049)
Total coaching	24	24	240	195.287	29.788	186.941	36.175	t = 2.198* (p = 0.029)

Table 5: Student-athletes perceptions on coaching competency in terms of performance in the competitions

Dimension of Competency	Num. of items	Min. score	Max. score	Performance in the competitions				Test differences between groups
				Winner		Loser		
				M	*SD*	*M*	*SD*	
Motivation	7	7	70	56.47	10.03	55.90	10.91	$t = 0.481$ ($p = 0.631$)
Games strategy	7	7	70	56.06	10.44	54.93	9.00	$t = 1.022$ ($p = 0.308$)
Techniques	6	6	60	48.25	8.92	47.44	7.78	$t = 0.844$ ($p = 0.400$)
Character building	4	4	40	32.36	5.69	31.83	5.46	$t = 0.844$ ($p = 0.399$)
Total coaching	24	24	240	193.494	33.847	190.355	31.126	$t = 0.840$ ($p = 0.401$)

The second analysis regarding competencies of coaches based on types of sports show that athletes from team sports rated higher score of their coaches than those from individual sports in all dimensions. Such results indicate that coaches for team sports are more competent in playing their roles for motivating, deciding game strategy, introducing good coaching techniques and successfully building characters among athletes.

Such findings can be described by the fact that a coach for a team sports needs more skills in managing, guiding and monitoring many athletes in the team. Such additional competency elements can be identified from the significant results of *t*-statistic for all dimensions except motivation. Therefore, these additional competency elements include his ability: (i) to identify strengths and weaknesses of every player in a team before a final strategy for combination of players be made to oppose a rival team, (ii) to apply appropriate guidance techniques and game strategy that is effective to lead the team to win a match and (iii) to create responsibility among the players so that they are functioning as a dynamic team during a match. In contrast, a coach for individual sports may provide a hundred percent attention on his athlete. However, this result cannot be simply judged that coaches for team sports are more superior to coaches for individual sports.

In comparison of the perceptions between winners and losers, the results revealed that there was no significant difference on each of the dimension of coaching competency. The mean scores of both groups are just indicated a small differences. Thus, this could be implied that regardless of whether they won or lost in the competition, the student athletes perceived the competencies level of the coaches have demonstrated with equal competencies in coaching.

These findings could be explained that the perceptions of student-athletes are more likely being influenced by their previous sporting experiences as an athlete whether before they were with the current team or with the current team for quite some times under the supervision of different coaches, and thus, as a result of that experiences they were not too dependent from their current coaches.

Relationship between performance and length of experience

As for research question (c), "Does the performance of athletes is influenced by length of experience under supervision of their coaches? Figure 1 shows the fluctuations of both groups of athletes who won and loss in the competitions based on their cumulative length of supervision.

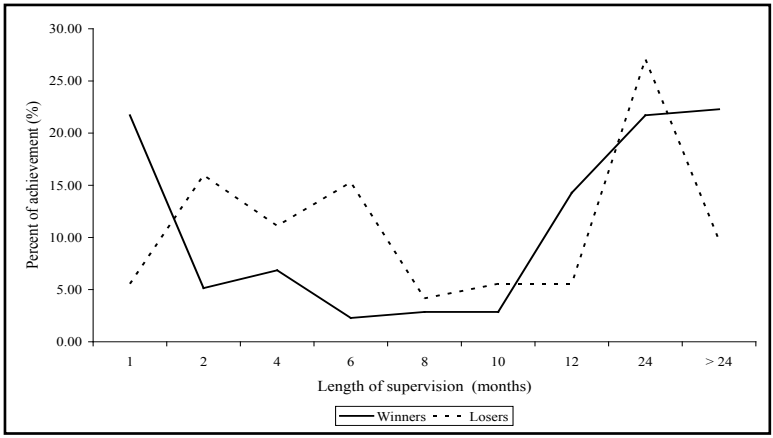

Figure 1: Correlation between performance and length of supervision

Fluctuations as depicted in Figure1 can be summarised in three phases. Phase I is for beginner where the athletes are just a month with the coaches. In Figure 1 we can see that there are more athletes who won in the competitions. Such result may explain a good start communication between coaches and athletes where both parties were at the similar agreements on choosing they types of training, strategy and tactics of games. It was also not possible that the athletes themselves were talented for the games which they possessed the skills and techniques prior to join universities' teams.

Phase II (2 to 10 months) however has reversed result where the percentage of athletes who loss in the competitions was larger than the winners. If we consider that students join the universities' teams at the beginning of their registration to the university, then the first six months or the first one year at the university was a period where a student struggles to balance their academic classes and training sessions. In Malaysia, most universities allow the new students to register for 15 to 21 credit hours for courses thus it is more to say that the students will be burdened with many assignments. Consequently, students have to limit themselves to have extra training hours. Besides, achievement in sports especially at the university environment has not been recognised with extra points for grading purposes, therefore one may take for granted that there is no issue whether you are a winner or a loser.

Phase III (after 10 months) depicts another different scenario where more athletes performed well in their games in general. This gives us some information that athletes have aligned themselves with the trainings and coaches. A result of chi-square test indicates $\chi_8^2 = 57.601$ (p-value < 0.000) which means that the length of time an athlete was supervised may influence his performances in the competitions. The behaviour of influence was presented in Figure 1.

CONCLUSIONS

Results from this study have several important implications. This study has successfully demonstrated some levels of competency displayed by the coaches in public universities. Coaches' coaching competencies showed different approaches and styles of coaching to their athletes by using motivation, game's strategy, athletes' character building, and implement effective techniques in sports training. Thus, given this knowledge, the coaches can use the important structures in the coaching competencies as a guide to act or behave as necessary in appropriate circumstances. This is because the behavior of coaches that do not suit the needs of athletes and organizations, if adopted would bring adverse implications on the development and progress of the athletes and the team.

In addition, the knowledge gained from this study can provide valuable input to the development of coaching development program to the parties concerned, such as universities, the Ministry of Higher Education, the National Sports Council, and sports bodies. The results of this study can provide meaningful information to plan the structure of the sports coaching education program to be more complete and systematic. The study to some extent can contribute in the selection procedure of an effective coach in preparing an excellent sports team and sound athlete.

The results of this study could also encourage the coaches to appreciate the differences of their athletes. In particular, the coaches can use these findings to improve their understanding of the student-athletes from different backgrounds who observe the level of their coaching competencies compared to coaches who have less knowledge of cultural values and experience. Thus, these findings can be used to illustrate how the collective reality of the coaches' approaches and strategies in terms of providing encouragement, games strategies, technical skills and character building of the athletes.

It is recommended that future studies on the coaches' coaching competency should take into account on other variables such as athletes' past experience, level of competition, the status of athletes and family backgrounds that may have influenced on the perceptions of student-athletes. Besides, this study also suggests that future studies should also utilize qualitative methods as well to acquire more objective data. It is hoped that there are other researchers also interested to conduct studies pertaining to this issues in providing meaningful contribution to the discipline of sports, especially in management and sports science in this country.

ACKNOWLEDGEMENTS

The authors would like to extend their appreciation to the Universiti Utara Malaysia and Research Innovation Management Centre for the financial support and who make this presentation possible.

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Effectiveness of an Isocaloric Daily Use Food and Sports Drink as Recovery Aids on Subsequent High-Intensity Cycling Performance

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Abstract

Post-exercise recovery (fluid and energy intake) is one of the important factors for subsequent exercise performance. This study was undertaken to investigate the effectiveness of a daily used food (sago and soy) as a recovery aid as compared to a commercial sports drink on subsequent high-intensity cycling performance. Seven cyclists (age: 15.3 ± 0.5 years, weight: 56.0 ± 4.4 kg) participated in this cross-over study. On each trial, subjects went through the glycogen depletion exercise process, followed by 4-hour recovery period and then performed time to exhaustion test (exercise at 85% VO_2max). During the 4 hours recovery phase, subjects ingested isocaloric supplement (24 kcal/100 mL) either sago (SG), a locally available carbohydrate, sago-soy (SGS), a locally available combination of carbohydrate protein supplement or sports drink (SPD), at the rate of 4ml/kg body weight, in the form of supplement drink, at every 30 minutes (8 times in 4 hrs period). Post-exercise ingestion of the isocaloric sago-soy, in comparison with the sago and sports drink, resulted in no significant difference of time to exhaustion (SG: 20.57 ± 7.55, SGS: 20.00 ± 5.00 and SPD: 22.14 ± 3.90 min) during a subsequent exercise. Blood samples were taken before exercise, after exercise, every hour during recovery, before subsequent exercise and after subsequent exercise during the trial. Results showed that subsequent high-intensity cycling performance did not differ statistically between SG, SGS and SPD trials. Similarly, plasma insulin, plasma glucose, plasma free fatty acid, plasma lactate, plasma ammonia and plasma creatine kinase concentration were not statistically different between trials. We assumed that the combined sago and soy, sago alone and sports drink might have elicited similar effects in glycogen restoration during recovery. There were also no significant differences in percentage changes of plasma creatine kinase after 24 hours of exercise (SG: 37.3 ± 10.2, SGS: 38.0 ± 15.9 and SPD: 32.3 ± 11.6 %) , indicating that there were no significant differences on degrees of muscle damage. Hence, it is concluded that a daily use food like, sago or sago-

soy is effective as a post-exercise recovery aid as compared to a commercial sports drink in maintaining high intensity endurance performance.

INTRODUCTION

Glycogen depletion and hypoglycaemia have been associated with fatigue and decrement of performance (Galasetti *et al*., 2001; Tsintzas *et al*., (1996). Several previous studies have been carried out to investigate the ways to reduce the rate of muscle glycogen depletion in order to maximize athlete's performance (Burke, 2001; Mancini *et al*., 1999; Rennie *et al*., 2001). Inadequate muscle glycogen stores before heavy exercise results early onset of fatigue. Post-exercise carbohydrate ingestion is important for recovery as it restores muscle glycogen (Lavenhagen *et al*., 2001). It is advisable to ingest fluid that contains carbohydrate as energy supply during recovery period immediately after exercising especially when the recovery period is short and another exercise have to be performed later. Failure to achieve adequate restoration of fluid balance and muscle glycogen synthesis can impair performance output. This condition is experienced by most athletes during training or in competition (Shirreffs *et al*., 2004).

A study showed that inclusion of protein into carbohydrate beverages produced benefit over traditional carbohydrate beverages alone (Romano-Ely *et al*., 2006). Theoretically, protein contributes up to 15% of total energy expenditure in prolonged bouts of exercise and could enhance performance (Schroder *et al*., 2008). The combination of carbohydrate-protein beverages have been shown to extend performance time to fatigue (Ivy *et al*., 2003), restores post-exercise muscle glycogen faster than the carbohydrate supplement alone (Ivy *et al*., 2002) and reduces post-exercise muscle damage (Romano-Ely *et al*., 2006; Saunders *et al*., 2004). To date, there are some controversies about carbohydrate protein supplementation where the addition of protein to carbohydrate beverages showed no greater glycogen resynthesis or glycogen sparing compare to the carbohydrate only beverages and failed to enhance recovery of exercise-induced muscle injury (White at al., 2008). Another studies showed that the addition of protein to a high amount of carbohydrate did not enhance post-exercise muscle glycogen synthesis despite of a further rise in plasma insulin (Jentjens *et al*., 2001) and these beverages also failed to improve time trial performance (Van Essen & Gibala, 2006). The reasons of the inconsistency in the findings of the previous studies mentioned above can be due to the methodological variations, the differences in carbohydrate and protein concentrations in the supplemented beverages, types of supplemented carbohydrate and protein, beverage administration protocols, and differences in the recovery period.

Commercially available sports drinks are designed as supplemental fuel to be used during exercise while others are taken immediately after exercise to facilitate recovery and improve subsequent performance (Romano-Ely *et al*., 2006). So, readily available carbohydrate-protein supplementations such as sago-soy protein as a post-exercise recovery drink needed to be tested in this research and it then can be compared with readily available commercialized sports drink in market. These specific sago-soy protein meal based can be patterned in the laboratory beside the expectation of giving a positive findings in field of sports. In addition, the resources of the basic ingredient such as sago and soy protein are easily available in the local market at a low cost. Therefore, it is potentially commercialized and suitable to be developed as a new sports supplementation meal for exercise in our market respectively.

METHODS

Subjects and Preliminary Testing

Eight state level male cyclists from Kelantan with age ranging from 15 to 25 years were recruited for this study. The cyclists had training and competition ranging from 1 to 3 years. The Human Research and Ethics Committee of School of Medical Sciences, University Sains Malaysia approved the study and experimental protocol. In brief, the subjects characteristics (mean ± SD) were age: 15.3 ± 0.5 years; height: 169.6 ± 4.9 cm; weight: 56.0 ± 4.4 kg; maximum heart rates (HR): 175 ± 10 beat.min^{-1} and maximum oxygen uptake (VO_{2max}): 61.3 ± 3.2 mL.kg^{-1}.min^{-1}. The VO_{2max} and maximum HR values were determined during an incremental cycle to exhaustion on an electronically braked cycle ergometer (Lode Groningen BV, The Netherlands).

Experimental Trials

All subjects completed three experimental trials in random order with a minimum gap of 7 days in between the consecutive trial, and at the similar time of the day of the experiment. Subjects reported to the laboratory after 10 to 12 hours of overnight fast. For repeated blood sampling, an indwelling cannula was inserted into anticubital forearm vein. A standard breakfast of 2 slices of white bread (Gardenia®) with 250 mL of drinking water was given to the subject 30 minutes prior to exercise. Subject then warmed up for 2 minutes without load on cycle ergometer. After warming up, an 8 mL baseline blood sample was drawn at -91 minutes. After taken baseline sample, the subject performed repeated cycling for 91 minutes to deplete glycogen.

Subject then rest and blood sample was drawn at 0 minutes. After that subject immediately consumed 4 mL/kg of body weight/hour (Van Nieuwenhoven *et al*., 2000) of sago/sago-soy/sports drink at 0, 30, 60, 90, 120, 150, 180 and 210 minutes (Van Loon *et al*., 200). Blood samples were also drawn immediately before the subject consumed sago, sago-soy, or sports drink at 60, 120, 180 and 240 minutes. After 4 hours of recovery, subject cycled at 60% of their VO_{2max} (60 RPM) for 10 minutes as warm up followed by cycling at high-intensity (85% of their VO_{2max} at 80-90 RPM) until exhaustion. Fatigue has been determined at subject's own volition of their cadence dropped below 60 RPM after receiving verbal encouragement.

Post exercise blood sample was drawn after the cycling to exhaustion session. All of the blood samples were used to analyze for plasma glucose, plasma insulin, plasma ammonia, plasma lactate, plasma free fatty acid, plasma creatine kinase and calculation of plasma volume changes. After 24 hours, subject blood sample was collected (2 mL) to analyze plasma creatine kinase. Plasma creatine kinase was measured after cycling until exhaustion was compared with plasma creatine kinase after 24 hours.

Blood Sampling and Analysis

For blood sample collecting, an indwelling cannula (BBraun, Germany) was inserted into anticubital forearm vein for repeated blood sampling. Eight millilitres of venous blood was drawn during each blood sampling for analysis of blood hematocrit level, plasma free fatty acid, plasma glucose, plasma lactate, plasma insulin, plasma ammonia and plasma creatine kinase (immediately after exercise and 24 hours after exercise). For analyzing plasma glucose and plasma lactate, sodium fluoride anticoagulant was used for collecting the blood samples. Collecting the blood samples for plasma insulin, plasma ammonia and plasma creatine kinase analysis, lithium heparine anticoagulant was used. EDTA anticoagulant was used for collecting blood samples for plasma free fatty acid analysis and hematocrit fraction analysis. All the plasma samples were pipette into 1.5 mL storage bullet tubes and stored in freezer at -81°C (Thermo Forma -86 ULT Freezer, United States). For blood glucose analysis, glucose reagent test kit (Randox Laboratories Ltd. United Kingdom) was used for the quantitative determination of plasma glucose levels. Glucose was determined by using enzymatic oxidation method in the presence of glucose oxidase. Insulin Hormone Reagent (Diagnostic Products Corporation, United States) with the IMMULITE® immunoassay system was used for the measurement of plasma concentration of insulin hormone. Ammonia Reagent Kit (Thermo Electron, Australia) was used for determination of plasma ammonia levels. Ammonia was determined by enzymatic oxidation method in the presence of glutamate dehydrogenase. FFA was determined by using FFA reagent kit (WAKO® NEFA C,Wako Pure Chemical Industries, Ltd, Japan).

Statistical Analysis

All the statistical analysis were computed by using the Statistical Analysis for the Social Sciences (SPSS) version 12.0 (SPSS Incorp, United States). Normality was established using Kolmogorov-Smirnov test. Descriptive statistics were calculated for all dependent variables. All the data reported were expressed as mean and standard deviation (Mean ± SD). Analysis of data was set at 95% confidence interval and α was set at 0.05. Repeated measure ANOVA was used to determine the differences of the measured parameters between time and supplementation trial. One-way repeated measure ANOVA have been applied to time to exhaustion, plasma insulin levels, plasma glucose levels, plasma free fatty acid levels, plasma lactate levels, plasma ammonia levels, plasma creatine kinase levels, oxygen uptake, body weight changes, heart rate, core temperature, haematocrit levels and plasma volume changes.

RESULTS

Time to exhaustion was used to determine subject's cycling performance showed that there was no statistical significant difference ($p>0.05$) between sports drink (SPD), sago (SG) and sago-soy (SGS) trials. The mean time to exhaustion in SPD, SG and SGS trials was 1257.14 ± 463.8 seconds, 1222.86 ± 290.2 seconds and 1351.43 ± 237.7 seconds respectively (Figure 1).

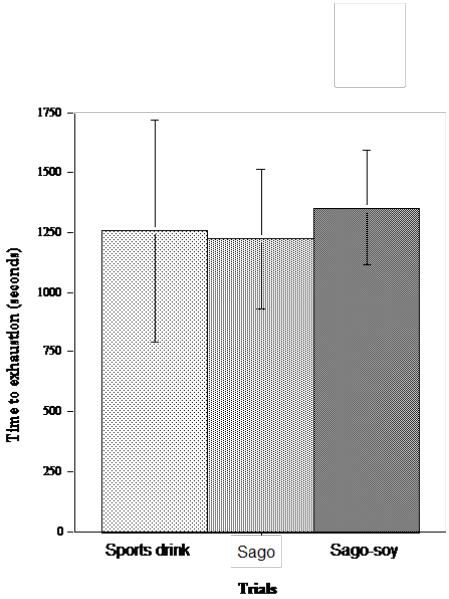

Figure 1: Time to exhaustion in sports drink (SPD), sago (SG) and sago-soy (SGS) trials.

There was a significant main effect of time on plasma insulin in SPD, SG and SGS trials ($p < 0.001$) (Figure 2). One way ANOVA with repeated measures for each trial revealed that in SPD, SG and SGS trials, plasma insulin level significantly decreased over time during both glycogen depletion and time to exhaustion phases, however plasma insulin concentration increased during recovery. Plasma insulin concentrations did not show any significant differences at any time points between SPD, SG and SGS trials in all three phases.

There were significant main effects of time in plasma glucose in all the three trials (Figure 3). In glycogen depletion phase, plasma glucose decreased significantly after 91 min of repeated cycling. In the recovery phase, plasma glucose increased significantly over time. In the time to exhaustion phase, significant decrease in plasma glucose was observed in SG trial. There were no significant differences in plasma glucose level at any time point between the three trials, except at the end of glycogen depletion phase between SPD and SG trials.

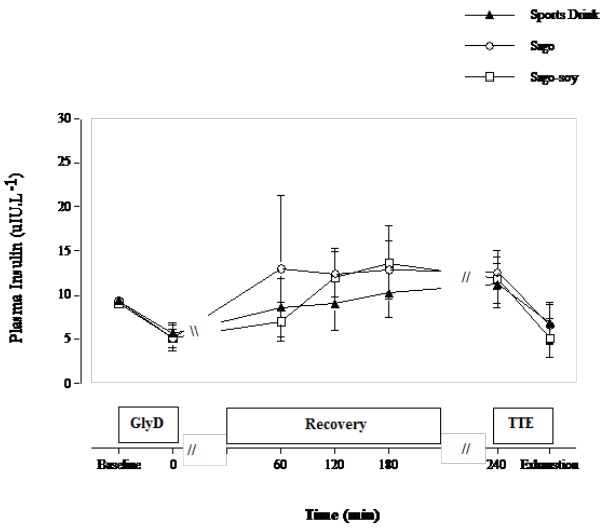

Figure 2: Plasma insulin during glycogen depletion, recovery, and time to exhaustion phases of sports drink (SPD), sago (SG) and sago-soy (SGS) trials.

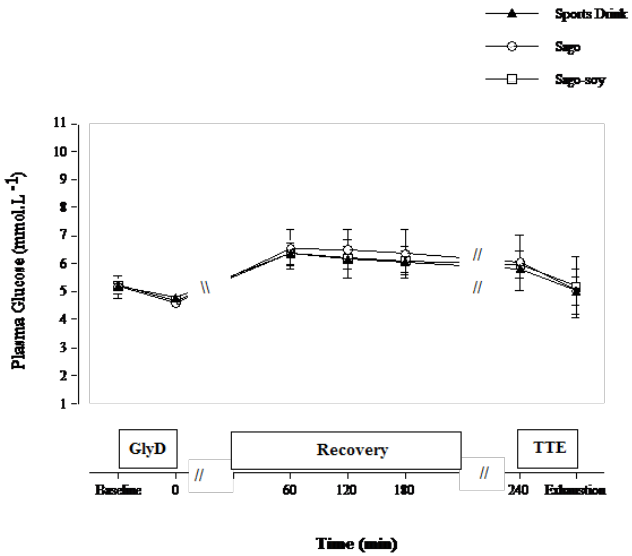

Figure 3: Plasma glucose during glycogen depletion, recovery and time to exhaustion phases of sports drink (SPD), sago (SG) and sago-soy (SGS) trials.

Means of plasma creatine kinase immediately after exercise, 24 hours after exercise and percentage of creatine kinase changes (%) during SPD, SG and SGS trials are shown in

Table 1 and Figure 4. There was no significant difference ($p > 0.05$) in percentage of creatine kinase changes between all three trials.

Table 1: Plasma creatine kinase concentration immediately after exercise and after 24 hours of exercise in sports drink (SPD), sago (SG) and sago-soy (SGS) trials. Data presented in mean ± SD

Trials	Plasma creatine kinase ($IU.L^{-1}$)		Percentage change of creatine kinase (%)
	Immediately after exercise	24 hours after exercise	
Sports drink	217.0 ± 50.3	333.0 ± 110.1	32.3 ± 11.6
Sago	188.9 ± 54.2	304.3 ± 83.5	37.3 ± 10.2
Sago-soy	211.0 ± 124.4	323.9 ± 150.7	38.0 ± 15.9

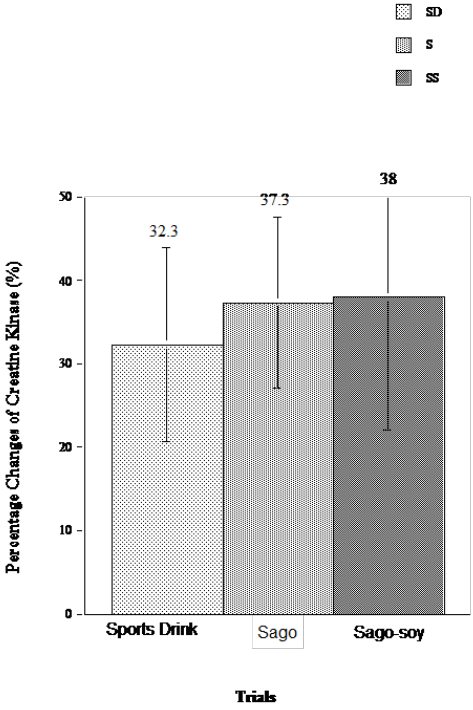

Figure 4: Percentage changes of creatine kinase 24 hours post-exercise compared to immediately after exercise in sports drink (SPD), sago (SG) and sago-soy (SGS) trials.

DISCUSSION

Exhaustion was defined as the point at which the subjects volitionally stopped exercising and were unable to maintain their chosen cadence (Karp *et al*., 2006). In the present study, we compared three isocaloric beverages with different form of macronutrient, i.e. sports drink, sago and sago-soy beverages on exercise recovery. It was found that there were no significant differences in exercise performance, i.e. time to exhaustion in the cycling performance phase between the three types of supplementations (Figure 1), implying that ingestion of isocaloric sago and sago-soy beverages were as effective as sports drink for recovery.

In several previous studies, no difference in post-recovery exercise performance were reported (Bilzon *et al*., 2002; Fallowfield & Williams, 1997; Wong & Williams, 1997). It was reported that the reasons for the lack of positive findings of these studies were the failure to rehydrate the subjects, and influence of large amount of carbohydrate on the mood states of the subjects, where 1.0 or 3.0 g of $CHO.kg^{-1}$ body weight were provided immediately and 2 hours after exercise during 4-hour recovery period (Fallowfield & Williams, 1997). In the present study, sago supplementation elicited the same effects as sports drink on subsequent cycling performance. This reflects that the amount of carbohydrate prescribed was appropriate for glycogen restoration during the recovery phase.

Regarding effects of CHO-electrolyte beverages on subsequent exercise performance after recovery. Fallowfield *et al.* demonstrated that supplementing subjects with a carbohydrate-electrolyte beverage after prolonged exercise could enhance the recovery process. Their subjects were provided with either 1 g $CHO.kg^{-1}$ body weight of a 6.9% CHO-electrolyte beverage or equal volume of placebo immediately and 2 hours after 90 min run at 70% VO_{2max}. Subjects were allowed to recover for 4 hours before subsequent run at 70% VO_{2max} to fatigue. During the run to fatigue, subjects who received the CHO-electrolyte beverage ran approximately 22 min longer than those who received placebo. Similarly, Wong *et al*, reported that the ingestion of a CHO-electrolyte beverage is an effective means of restoring endurance capacity when the prescribed recovery time was four hours. Comparisons between the present study and these two previous studies showed that there were differences in the methodology, i.e. timing of ingestion, frequency of ingestion and duration of recovery. Similar effects in glycogen restoration can be seen with the prescribed sports drink (Gatorade®) containing CHO-electrolyte, sago and sago-soy in the present study. These research findings showed that sago and sago-soy can be used as an alternative of sports drink for glycogen restoration during recovery.

Regarding effects of CHO-protein beverages on subsequent exercise performance after recovery, Williams *et al*, (2003) compared the effects of a high carbohydrate-protein (CHO-PRO) beverage containing electrolytes on short-term exercise recovery with that of a traditional 6% CHO-electrolyte sport beverage (SB). The study showed that providing a beverage containing a high concentration of carbohydrate and protein could accelerate the recovery process. In the present study, sago-soy was used as a CHO-PRO beverage. The present study findings showed that combination of sago-soy elicited similar effects as sports drink.

In the present study, during the 4 hours recovery period, plasma insulin concentrations increased significantly in all three trials. It is speculated that plasma glucose increased with the ingestion of SPD, SG and SGS supplement which contain CHO. Subsequently, plasma insulin increased in response to the increased in plasma glucose level. There were no significant differences in plasma insulin level at any point during recovery between the three trials, implying that these three supplements may elicit similar effects in glucose metabolism and glycogen restoration. Ivy (2004) reported that absorption of the exogenous carbohydrate during recovery period increased the blood glucose concentration; consequently hyperglycaemia causes hyperinsulinaemia and as a results of increased in muscle insulin sensitivity. Similarly, in a study by Williams *et al*, (2003) the subjects were hyperinsulinaemia after ingesting carbohydrate-protein beverages immediately after the 2-hours glycogen depletion ride. Ivy (2004), found that exogenous carbohydrate ingestion immediately after exercise gives better effect on glycogen restoration compared to after 3 hours of exercise, thus modulation of insulin action may impact whole body and muscle protein accretion, as well as glucose deposition after exercise.[6] In the present study, the absence of significant difference in plasma insulin level at the end of the recovery phase among SPD, SG and SGS ingestion which were given immediately following exercise, may reflect that SG and SGS elicited similar effects as SPD in muscle's glycogen recovery.

Regarding plasma glucose, in the present study changes in plasma glucose over time in the three trials exhibited similar trend with plasma insulin, where plasma glucose decreased significantly in glycogen depletion and time to exhaustion phases, and increased over time in the recovery phase as observed in plasma insulin (Figures 2 and 3). This observation reflects that plasma insulin response is related to the plasma glucose level. The absence of significant differences between the three trials at the end of time to exhaustion phase implies that SPD, SG and SGS supplements elicited similar effects in plasma glucose level. The roles of plasma glucose and plasma insulin in glucose metabolism and muscle glycogen restoration in the present study have been discussed in the aforementioned sections.

Both prolonged endurance (Saunders *et al*., 2004; Seifert *et al*., 2005) and short bouts of high intensity exercise (Wojcik *et al*., 2001) are associated with elevated muscle tissue damage. In the present study, plasma creatine kinase was used as an indicator of muscle damage and it was measured at 24 hours post-exercise as plasma creatine kinase level peak at 24 hours after exercise (Romano-Ely *et al*., 2006)

It showed that there were no significant differences in percentage of plasma creatine kinase changes (Fig 4) and elevation of 24 hours post-exercise creatine kinase values over immediately after exercise values among SPD, SG and SGS trials (Table 1), indicating that SPD, SG and SGS elicited similar effects on creatine kinase value which reflects muscle damage.

By comparing results of the present study with Romano-Ely *et al*, (2006) and Saunders *et al*, (2004) all the three SPD, SG and SGS trials in the present study, it was found that 24 hours post exercise peak plasma creatine kinase levels were 333.0 ± 110.1 $IU.L^{-1}$, 304.3 ± 83.5 $IU.L^{-1}$and 323.9 ± 150.7 $IU.L^{-1}$ (Table 1) respectively, while results of Romano-Ely *et al*, (2006) and Saunders *et al*, (2004) are 272.9 ± 169.4 $IU.L^{-1}$ and 216.3 ± 122.0 $IU.L^{-1}$ of plasma creatine kinase in carbohydrate-protein trials respectively. The discrepancy between the present studies with these two previous studies may be due to differences in methodology, types of carbohydrate and protein used, subjects' fitness level, and types and intensity of prescribed exercise.

Regarding effects of addition of protein to carbohydrate to muscle damage, several previous studies reported that addition of protein to carbohydrate beverages may provide protective effects. (Romano-Ely *et al*., 2006; Saunders *et al.*, 2004; White *et al*., 2008). Saunders *et al,* (2004) demonstrated that peak post exercise plasma creatine kinase level were 83% lower after the carbohydrate-protein trial (216.3 ± 122.0 $U.L^{-1}$) than the carbohydrate trial (1318.1 ± 1935.6 $U.L^{-1}$). The authors concluded that a carbohydrate beverage with additional protein calories could produce significant improvements in time to fatigue and reductions in muscle damage in endurance athletes. However it was speculated that these improvements may be caused by extra calories contributed by the protein. Subsequently, a follow up study[8] was conducted to compare isocaloric carbohydrate-protein-antioxidant and carbohydrate alone. It was found that no differences in time to fatigue were observed between carbohydrate-protein-antioxidant (CHOPA) and carbohydrate (CHO), and CHOPA could attenuate post exercise muscle damage compared with isocaloric CHO beverage. It was speculated that the controversy of these studies was the attenuation of muscle damage may be aided by antioxidants but not protein alone. In the present study, SG (CHO) and SGS (CHO-protein) elicited the similar effect on muscle damage 24 hours post exercise. So the discrepancy between the present study with the previous studies could be due to differences in the types of CHO and protein used.

CONCLUSION

In conclusion, sago, sago-soy and sports drink supplementation are equally effective as a post-exercise recovery aid for subsequent high intensity cycling performance, implying that daily used food i.e. sago and soy are equally effective as a commercial sports drink in optimizing muscle glycogen synthesis as well as fluid replacement for the improvement of post-exercise endurance performance. In addition, costs to produce sago-soy and sago beverages were cheaper than commercially available sports drink. The limitations of the present study are subjects were assumed to have the same level of depleted glycogen at the end of glycogen depletion phase. Muscle biopsy was not performed to determine the actual glycogen content in the muscle of the subjects.

ACKOWLEDGEMENTS

Authors acknowledge Universiti Sains Malaysia for financial support, and thank Sports Science Unit Laboratory Staff (Jamaayah, Norlida, Hafizah, Nawawi and Rozaid) for assistance in the experimental trials.

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Predictors of Physical Activity Among Elderly Patients in a Tertiary Center Malaysia

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Abstract

The burden of disease resulting from physical inactivity such as cardiovascular disease affecting elderly age group is high. The objective of this study was to determine the associated factors of physical activity among elderly attending outpatient clinics at Hospital Universiti Sains Malaysia. A cross-sectional study was conducted involving 339 elderly patients attending outpatient clinics at Hospital Universiti Sains Malaysia from June 2011 to March 2012. Mini mental state examination was used to exclude patient with severe dementia. Structured questionnaires consist of sociodemographic questionnaire and Malay version of modified Baecke questionnaire was used to collect the data in face to face interviews. The analyses were done using simple linear regression and General linear regression. Three hundred and thirty nine elderly were recruited. There were 142 (41.9%) male and 197(58.1%) female with the mean age of 67.7 (6.00). The associated factors for physical activity were age (adjusted b) -0.10 (95% CI -0.20,10.01), female -(adjusted b) 2.37 (95% CI-3.52,-1.21), not working (adjusted b) 1.76 (95% CI 0.46,3.06) and do not perceived body weight as a problem (adjusted b) 2.50 (95% CI 0.78,4.21). The predictors for physical activity level among elderly attending outpatient clinics HUSM were age, female, not working and not perceived body weight as a problem.

INTRODUCTION

Global health is being influenced by three trends that are population ageing, rapid unplanned urbanization, and globalization, which result in unhealthy environments and behaviours (WHO, 2010). Physical inactivity has been identified as the fourth leading risk factor for global mortality (6% of deaths globally). Physical inactivity is associated with many health problems such as coronary heart disease, diabetes, depression, obesity, osteoporosis and cancer (Warburton, 2006).

Study by Ferucci *et al.* in 1992 showed that physical activity in the elderly prolonged active life and decreases the percentage of remaining life that is spent in the state of disability.

This study also showed that the negative effect of inactivity on survival and length of disabled life is comparable and perhaps higher than the effect of smoking.

According to National Health and Morbidity Survey III done in 2006, overall prevalence of physical inactivity in Malaysia was 43.7% which represent 5 545 891 Malaysian adults and it was more prevalent in women, older adults, widow or widower and those who did not have formal education. Study among elderly population in Turki (Aslan et al, 2004) showed there were significantly positive associations between ‘‘not doing regular exercise’’ with age of 75 years or older, female, presence of a chronic disease and lower/higher BMI.

Although the benefits of regular physical activity are well known, a large proportion of the elderly population remain inactive. As the population of elderly is increasing steadily in Malaysia and physical inactivity is a modifiable risk factor, there is significant potential to increase the health and quality of life of older adults, as well as to improve the economic health of the nation through physical activity intervention strategies. Education of the general practitioners had a positive effect on health outcomes of their elderly patients (Kerse et al, 1999). General practitioners may have considerable public health impact in promotion of health for elderly patients.

An understanding of the factors that influence physical activity behaviour in our local older adults is needed to developing effective intervention strategies that will address the problem of physical inactivity in our population. The findings could suggest ways to motivate older persons to increase their level of physical activity, and thus decrease the extent of sedentary living–associated disability, illness, and need for medical care.
The objective of this study was to determine the factors associated with physical activity among elderly attending the outpateint clinics in Hospital Universiti Sains Malaysia.

METHODS

This is a cross sectional study conducted among 339 elderly patients attending outpatient clinics in Hospital Universiti Sains Malaysia from June 2011 to March 2012. The study includes all patients age 60 years and older who are physically independent. Those who are unable to walk independently or had restricted physical active and had cognitive impairment were excluded.

Physical activity is defined as any bodily movement produced by the contraction of skeletal muscle or any body movement that works muscles and uses more energy than when resting (Thompson *et al.*, 2003).

Elderly patient attending outpatient clinics Hospital Universiti Sains Malaysia who meet inclusion and exclusion criteria were included in this study. Mini mental state examination was used to exclude patient with severe cognitive impairment. Informed consent was taken before enrollment in the study. Structured questionnaires consist of socio-demographic questionnaire and Malay version of modified Baecke (MBQ) (Baecke et al. 1982). The questionnaires were used to collect the data in face to face interviews.

The Baecke Questionnaire was initially developed in 1982 by Burema, and Frijters. It is a short questionnaire to measure physical activity in healthy persons by referring to activities

over the past year. The questionnaire latter had been adapted by Voorrips and co workers to capture habitual physical activity specific in the elderly by deleting the employment items and adding the daily activity item. MBQ consists of

1) Household activities questions with 10 items. Each item has four to five possible answers to reflect physical activity.
2) Sport activities include the type of activity, the frequency of performance, and the number of months per year that the activity is performed.
3) Leisure time activities include the type of activity, the frequency of performance, and the number of months per year that the activity is performed.

All items result in a separate score that incorporates activity duration, frequency, and an intensity code based on energy costs. The total household, sport and leisure time activity score results in a continuous overall activity score. Back to back translation and a pilot study of the MBQ were done prior to the data collection. The MBQ was chosen for this study because it is able to measure unstructured physical activity such household activities and transportation as part of physical activity level thus making suitable for the elderly age group and the questionnaire is not specific to certain season such as winter or summer. However, the participants need to recall the physical activity done for the past one year.

Statistical Analysis

Data were analyzed using PASW statistics 18.0. The distributions and frequencies were examined for normality and inequality. Mean and standard deviation were calculated for numerical variables and frequency and percentages were calculated for categorical variables Data were analyzed using simple and multiple linear regressions. Significance was taken at p-value < 0.05.

RESULTS

Table 1 showed the baseline characteristic of the study participants. The mean age for the study participants is 67.7 (6.0). There were 42% male and 58% female. Table 2 showed types of physical activity done by the participants not including household activities. Most of them (52%) did gardening followed by walking. Simple Linear Regression showed that age, sex, educational status, occupational status and those who perceive their weight as a problem and disturb activities were significant associated factors of physical activity and General Linear Regression showed that only age, sex, occupational status and those who perceive their weight as a problem were significant associated factors of physical activity. Table 3 showed the simple and general linear regression analysis results.

Table 1: Baseline characteristic of the study participants

Variable	***N (%)***
Age	***67.7 (6.0)[a]***
Gender:	
Male	*142 (41.9)*
female	*197 (58.1)*
Race:	
Malay	*316 (93.2)*
Non Malay	*23 (6.8)*
Marital status:	
Married	*229(67.55)*
Widow/unmarried	*110 (32.45)*
Living arrangement:	
Alone	*27 (7.9)*
With spouse	*87 (25.7)*
With family members	*91 (26.8)*
With both	*110 (32.5)*
Income	*684.0 (639.8)*
Education level:	
No education	*98 (28.9)*
Primary	*145 (42.8)*
Secondary/tertiary	*96 (28.3)*
BMI	*25.0 (4.3)*
Perceived weight as a problem	*43 (12.7)*
Had Chronic illness	*244 (72.0)*

Table 2: Types of physical activity

Type of physical activity	***N (%)***
Indoor:	
Taking care of grandchildren	*13 (3.8)*
Outdoor:	
Gardening	*178 (52.0)*
walking	*46 (33.0)*
Cycling	*17 (5.0)*
Sport	*6 (1.7)*
Exercise	*5 (1.5)*

The following interpretations could be made:

1. For every 1 unit increased in age, there was a decreased of 0.1 unit in physical activity score (95% CI: -0.20, 10.01), after adjusted for other variables.
2. For every 1 unit increased in sex, there was a decreased of 2.37 unit in physical activity score (95% CI: -3.52,-1.21), after adjusted for other variables.
3. For every 1 unit increased in perceive weight as a problem, there was an increase of 2.50 unit in physical activity score (95% CI: 0.78, 4.21), when other variables are the same.
4. For every 1 unit increased in not working, there was an increase of 1.76 unit in physical activity score (95% CI: 0.46, 3.06), after adjusted for other variables.
5. R^2= 0.18, meaning that only 17.7% of the variance in physical activity score in the sample was explained by the four significant variables observed.

Table 3: The SLR and GLR analyses

Variable		**SLR**			**GLR**	
	B(95% CI)	**T stat**	**P value**	**B(95% CI)**	**T stat**	**P value**
Age	**-0.071 (-0.16,0.02)**	**-1.44**	**0.150**	**-0.10 (-0.20,10.01)**	**-2.13**	**0.034**
Occupation						
Working						
Not working	**0.96 (-0.35,2.26)**	**1.44**	**0.151**	**1.76 (0.46,3.06)**	**2.65**	**0.008**
Gender						
Male						
Female	**-2.12 (-3.28,-0.96)**	**-3.59**	**<0.001**	**-2.37 (-3.52,-1.21)**	**-4.03**	**<0.001**
Perceived weight as disturb activity						
Yes						
No	**2.02 (0.01,4.04)**	**1.98**	**0.049**			
Perceived weight as a problem						
Yes						
No						
	2.28 (0.54,4.02)	**2.58**	**0.010**	**2.50 (0.78,4.21)**	**-4.03**	**<0.001**
Education level:						
No education						
Primary	**1.49 (0.11,2.89)**	**2.12**	**0.035**			
Secondary/tertiary	**2.25 (0.73,3.78)**	**2.90**	**0.004**			

DISCUSSION

In this study increasing age is associated with lower physical activity. The result is similar with other studies. A study by Johannsen *et al*. (2008) showed that physical activity markedly lower in nonagenarians (>90 years old) compared with young and aged adults.

Another study by Black et al. suggested that the reduction in total energy expenditure in people of retirement age was due mostly to lower levels of physical activity (Johannsen *et al.*, 2008). Age related declined in physical activity levels might partly be biologically based since activity levels declined with age were observed across diverse population as well as in animal study (Sallis, 2000). There is a marked decline in total activity level after 70 years, which may be attributable to a increasingly sedentary lifestyle (Halal *et al.*, 2003). So aging population is known to have inactivity in their daily life as evidence by the studies mentioned.

We found that female is associated with lower physical activity compared to male. A study using the same questionnaire (MBQ) revealed that the level of physical activity among elderly women is low (Sternfeld *et al.*, 1999). The prevalence of physical activity at recommended levels is low, particularly in older women (Sproston and Primatesta, 2004). Among older women, current health and health related behaviours are stronger predictors than social factors of relatively early mortality. Within the socio-cultural environment, social support and having a companion for physical activity were identified as likely important determinants for various physical activity types and intensities. Berke *et al*. (2007) examined whether older persons who live in areas that are conducive to walking are more active or less obese than those living in areas where walking is more difficult and found that neighbourhood characteristics are associated with the frequency of walking for physical activity in older people.

In this study, those who are not working had higher physical activity level. This is because they had more time to do physical activity compared to those who are working. We also found that those who perceived they had body weight problem will be more physically active. This is understandable because those people would be more physically active in order to reduce their weight.

The present study has several limitations. The questionnaires need the participants to recall their physical activity for last 1 year which could cause inaccurate data and the elderly sample in this study was captured in the hospital setting which lead to Bearkson bias. This study will give more accurate result if done in community setting. We recommended that further study should be done to look for more suitable questionnaire for the elderly in Malaysia.

CONCLUSION

Elderly who are not working and do not perceived weight as a problem are associated with higher physical activity level However, increasing age and female are associated with lower physical activity level

ACKOWLEDGEMENTS

We would like to thank Universiti Sains Malaysia for the grant used to support this study. Last but not least, our gratitude to all subjects who participated in this study.

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Fall Risk Factors Among Malaysian Older Adults

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Abstract

Falls are the leading reason of injury-deaths among people above 65 years old. Multiple risk factors such as intrinsic and extrinsic factors contributed to the increment of fall rates. In order to meet the purpose of the study which is to establish a local data of fall risk factors among older population, a causal-comparative design was proposed. 212 potential participants (large effect size, η2 = .64) were recruited from four zones in peninsular of Malaysia. Participants were further divided into three groups which are young-old (65-74 years old), mid-old (75-84 years old) and oldest-old (>85 years old). Overall Stability Index (OSI) was assessed with the aid of Biodex Balance System SD device and the score index was collapsed to the high and low risk groups for further analysis. To make it consistent due to some of the participants is illiterate, a guided question interview-administered technique also used to acquire details about fall risk factors of the participants. Logistic Regression Analysis using Force Entry Method was performed to determine the intrinsic and extrinsic factors that could be the main contributor to the risk of falling. Data yielded four statistically significant results, which considered as major factors influencing to the risk of falling. The strongest predictor that contributed to the high level of fall risk was medical condition with reported odds ratio of 10.63 (OR = 10.63, 95% of CI = 1.617 – 69.950, p = .014) followed by mobility limitation (i.e. use an assistive device) (OR = 5.94, 95% of CI = 1.344 – 26.208, p = .019). Sensory deficit showed the third main contributor to the risk of falling with the odd ratio of .27(OR = .27, 95% of CI = .098 – .741, p = .011) and the last predictor that contributed to the risk of falling was age of the participants (OR = 1.36, 95% of CI = 1.228 – 1.512, p = .001). Identification of fall risk factors could prompt older adults to modify certain activities. Besides that, these results could be used to ameliorate some of the dearth of literature and may also assist in providing worthy intervention for the older adults who are in the 'high risk groups'.

INTRODUCTION

Ageing is a complex ongoing process of human life that has multifaceted factors and may influence health status, quality of life, functional status and the dependency of the person itself (Tinetti, Inouye, Gill, & Doucette, 1995). When numbers of older adults increase more rapidly than the other group of population, this particular population is said to be an ageing population. United Nations categorised 65 years old as a cut-off age of older adults and it is consistent with some ASEAN countries (United Nations, 2002). According to National Council of Senior Citizens Organizations Malaysia [NACSCOM (2007)], Malaysia currently has a population of approximately 26 million, of which 6.5% of age above 65 years. With a projected population growth of 2% annually, the population is expected to reach approximately 34 million in 2020, of which 3.2 million or 9.5% is expected to be above the age of 65 years. In the year 2035, the country is expected to have a population of about 46 million, of which 6.9 million or 15% will be above 65 years. It shows that, there are significant changes have taken place in our population structure over the last few decades. These changes were mainly a result of the 'demographic transition' experienced since the 1960's which witnessed decline in birth rates from 36.1% in 1965 to 23.2% in 2002 (NACSCOM, 2007). Nevertheless, if we relates with the previous statement, this age group make up a large and increasing percentage of Malaysian population. In the year 2035, Malaysia would fall within the category of an ageing nation.

As the number of older adult above 65 years increases, so does the incidence of falls and falls related injuries (Steven, 2005; Doweiko, 2000; Daley & Spinks, 2000; Tibbitts, 1996; Tinetti, Baker & McAvay, 1994; Tideiksaar, 1993; Jech, 1992). Falls defined as unintentionally coming to rest, trips or stumble to the ground or other surface lower than the body or a part of it (Nevitt, Cummings & Hudes, 1991). The 'endemic crisis' of falls among older adults has become a major problem for healthcare industry (Steven, Corso, Finkelstein, & Miller, 2006) and government organizations that have connection with this community population (Osei, Rasali, Hawkey, McCrae & Johnson, 2007). Risks of falling might be the most concern topic for older population because fall is an undetected disease. Ten percent of the falling cases had involved medical attention (Tinetti, 2003; Schwartz, Capezuti & Grisso, 2001; Alexander, Rivara & Wolf, 1992) and have high percentage of hospitalization (Tinetti & Williams, 1997; Runge, 1993). In fact, injurious falls are the third leading cause of hospitalization among this population segment (Normastura Abdul Rahman, Roszalina Ramli, Roslan Abdul Rahman, Haizal Mohd Hussaini, & Abdul Latif Abdul Hamid 2010). According to Hausdorff, Rios, & Edelberg (2001), the older adults who experienced fall incidents before, have big chances to fall again within six month (Stel, Pluijm & Deeg, 2003). Falls incidents may result hip fracture, femur fractures, wrist fractures, soft tissue injuries, dislocation, ankle sprains and the most crucial consequences of falls are fatality cases (Tinetti, 2003).

Falls was affected by multifaceted connection of multiple risk factors. Multiple risk factors such as intrinsic factors and extrinsic factors contributed to the increment of fall rates. Extrinsic factors are the factors that are more external in nature such as environmental hazards that increased the risk of falling during daily living activities. Older adults who lived alone or independently in the community more exposed to the several of extrinsic factors (Sattin, Rodriguez, DeVito, & Wingo, 1998). Intrinsic factors are age or disease-related changes, which occurred among older adults. There are a few intrinsic factors contributed to the increment of risks of falling such as limitation to perform activities of

daily living (Tinetti, Liu, & Claus, 1993), mobility disorder (Nevitt, De-Rekeneire, Visser, Peila, Cauley, & Tylavsky, 2003), medical condition or chronic illnesses (Tinetti, Williams, & Mayewski, 1986), polypharmacy (Tinetti, Doucette, & Claus, 1995), previous fall history (Tinetti, et al., 1986), fear of falling and cognitive impairment (Stel, Pluijm, Deeg, Smit, Bouter, and Lips, 2003). Not only that, involvement in physical activity which declines with age, will also increase the risk of falling (Mecagni, Smith, Roberts, & O'Sullivan, 2000).

Due to numerous conditions which may lead to risks of falling, steps to minimize or reduce the number of falls should be taken. First step is to identify level of fall risk among older adults and secondly the arrangement of an effective intervention program which will benefit to this age group. Most of the studies are from western. There are likely some differences in terms of culture, environment and knowledge that influenced this scenario. Therefore, it is extremely important to understand the fall risk factors from Malaysian scenario as to cover the lack of info on the factors influence risk of falling from developing country. According to Maki and McIlroy (1997), even the older adults without a fall history would still have 21% risk of falls. This finding emphasizes on the importance of determining the risk factor of falling that are potentially identify before the first fall as most of the older people and community in Malaysia are not aware of the fall risk or fail to recognise the risk factors.

As stated by Rogers, Rogers, Takeshima and Islam, (2003), many tools, test batteries or mechanisms can evaluate and test the balance index. Currently, there are different styles and techniques to assess the risk of falling (Rogers et al., 2003), for example, Berg Balance Test (Berg, Wood-Dauphinee, Williams, & Maki, 1992), Time Up and Go (Shumway-Cook, Brauer, & Woollacott, 2000), Tinetti Gait and Balance Test and etcetera. Generally, only balance index that represents level of fall risk quantified by force platform (Horak, 1997), but there are less evidences or studies that focused on the identification of balance in relation to fall risk factor variables using this device. Thus further insight are required to establish a local data and to understand the possible connections of fall risk level and fall risk factors by using force platform focusing on the latest version of which is Biodex Balance System SD (BBS).

METHODS

Research Design

In order to meet the purpose of the study which is to determine fall risk factors among older adults based on specific demographic factors, a causal-comparative design involving cohort group format were proposed. The goal of this design is to demonstrate the possible cause and effect relationship by observing an existing condition or state of interaction and searching back in time for plausible causal factors.

Participants

A number of 212 participants who were 65 years old and above, were recruited for this study by clustering the states in Peninsular of Malaysia into four zones, which are North, South, East and West. Then, participants were further sorted into three age groups which are young-old (65-74 years old), mid-old (75-84 years old) and oldest-old (>85 years old). Inclusion and exclusion criteria have been put forth prior to the participants' recruitment. The study was approved by Institutional Ethical Committee of Universiti Teknologi MARA

(UiTM) [REF: 600-RMI(5/1/6)] and fully funded by Excellent Fund of UiTM [REF: 600-RMI/ST/DANA5/3/DST(28/2011)].

Instrumentation and measurement

Biodex Balance System SD (BBS) device was used in terms of getting the Overall Stability Index (OSI) data that represent level of fall risk among older population. BBS used to quantify each participant's ability to maintain balance on the BBS platform. BBS circular platform diameter is 21.5 inch (55 cm), that can moved along Anterior-Posterior (AP) and Medial-Lateral (ML) axes simultaneously. The platform also can tilt up to twenty degrees (20^0) from horizontal in all directions or 360^0 range of motion. The BBS device is interface with computer software (Biodex Software 2.09 & Firmware 1.33). It can determine three separate measurements such as Anterior-Posterior Stability Index (APSI), Medial-Lateral Stability Index (MLSI) and Overall Stability Index (OSI). The OSI index is the best indicator to observe the ability of the participant to balance on the top of the platform and shown through a coloured touch screen display. A high score index of OSI indicates poor balance. For this current study, test-retest reliability method was used to determine reliability of this device and the data shows that the BBS reliability is $r = .798$.

With the intention of acquiring details in fall risks documentation form, which consist of socio-demographic and fall risk factors of the participants, a one-to-one interview-administered technique has been conducted and this technique was used to all participants to make sure the results were consistent and reliable. It is also much more convenient as some of the participant is illiterate. All the participants were interviewed according to the guided questions in the fall risk factors documentation form that a priori adapted and validated. In the fall risk documentation form, there were four sections, which consists of; Section A: Fall Risk Screening Test (Result Form), Section B: Documentation for Socio-demographic Factors, Section C: Documentation for Intrinsic Factors and Section D: Documentation for Extrinsic Factors.

Procedures

In order to exclude any cognitive impairment participants which may influence their recall of information, one preliminary test by using Malay version of Elderly Cognitive Assessment Questionnaire (ECAQ) adapted from Kua & Ko (1992) was utilized. This ECAQ assessed two elements of cognitive functions, which are memory and orientation-information. The ECAQ score is considered normal when the score is more than seven (>7) and the participants were selected to participate in the study.

Then, height and weight of selected participants was taken by using SECA Bodymeter 206 and SECA Weight Scale 881 because appropriate height and weight need to be keyed in into computerized BBS device. For the safety precaution purposes during the testing protocol, participant needs to wear full body harness before stepping on top of BBS platform. Participant was positioned bilaterally barefoot and some adjustment of the foot position needed until the participants felt relax and comfortable on the top of BBS device platform. Participants also needed to look straight ahead to the BBS computerised touch screen monitor. The foot position coordinates were recorded according to the platform grid because it is to ensure that the data gathered from that participant was constant throughout the test sessions. The participant was instructed not to move his feet until the end of the measurement (Figure 1).

Figure 1: Participant position on Biodex Balance System SD device

One minute was given to the participants for familiarization and adaptations to the BBS device followed by the fall risk testing procedure to reduce any learning effects. Participants were allowed to use handrails during familiarization protocol but not during the actual testing period. Twenty seconds (20s) testing duration for three trials of measurement was given separated by ten seconds (10s) rest intervals with bilateral stance with feet shoulder width apart over the midline of the platform and all participants were evaluated with their eyes open (Figure 1). The testing procedure for BBS platform started from level twelve (static level) to level six (moderate dynamic level) with automatically reduced the stability level at every 3.33 seconds.

Then, fall risk screening test was performed with the BBS, which comprises a multiaxial platform that was connected to a screen located in front of the participant. The participant was instructed to keep himself balances on top of the platform. The amount and degree of displacements of the tilting platform can be observed by the participant with the help of a cursor moving on the screen. Upon completion of the testing, participants underwent the interview session. Participants were interviewed according to the questions related to the fall risk factors. The session took about 15-20 minutes to be completed.

Statistical Analysis

BBS device would automatically calculated the exact index whether the participant have high risk index or low risk index and this index was compared with the normative norms that provided by the device itself. This normative norms act as a cut off point to differentiate the high fall risk person and low fall risk person. The OSI values need to be recorded as high risk and low risk compared to the actual continuous data with the aid of Statistical Package for Social Science (SPSS version 16).

Direct logistic regression analysis using Force Entry Method was performed to assess the impact of several factors that possibly contributed to high risk of falling. The models consist of nine independent variables or predictors for intrinsic factors and seven predictors for extrinsic factors. The analysis for the intrinsic and extrinsic factors was performed separately. This analysis also purposely to rank the fall risk factors according to the impact

level (odds ratio) to the risk of falling. For all analysis, the significance criterion level was set at .05 (5%) and the power was set at .8 (80%).

RESULTS

Participants' physical characteristic and socio-demographic profile were tabulated in Table 1. The entire participants (N = 212) aged 76.6 ± 7.89 that followed the inclusion criteria were segregated into three age groups as they were recruited. The numbers of male and female participants in each group were approximately close to equal.

$$*P(Y) = \frac{1}{1 + e^{-(b0+b1+b2+b3+...)}} \quad (1)$$

*Probability high risk of falling = (involved three or more factors either intrinsic or extrinsic)

Furthermore, Table 2 illustrates the contribution or importance of each of the independent variables (predictors) to the model (refer equation 1). From the table, there are four predictors that contribute significantly to the model which are medical condition (p = .014), sensory deficit (p = .011), mobility limitation (p = .019) and age (p = .001). It shows that the four significant results were a major factors influencing whether a person have high level of fall risk. The strongest predictor that contributed to the high level of fall risk was medical condition with reported odds ratio of 10.63 (OR = 10.63, 95% of CI = 1.617 – 69.950, p = .014). This indicated that participants who have several types of medical condition were over 10 times more likely to have high level of fall risk compared to those who did not have any medical conditions. Moreover, the mobility limitation (i.e. use an assistive device) present the second highest predictor that contributed to the high level risk of falling (OR = 5.94, 95% of CI = 1.344 – 26.208, p = .019) and it means, the participants who are using assistive device to walk have 5-6 times more likely to have high level of fall risk. For sensory deficit, it showed that the odds ratio of .27 (OR = .27, 95% of CI = .098 – .741, p = .011). It signifies that participants who overcome the sensory problems, the less likely the participants reported to have a high level of fall risk. The last predictor that contributed to the model was age of the participants (OR = 1.36, 95% of CI = 1.228 – 1.512, p = .001) and the odds ratio illustrated that the increment of age will cause high level of fall risk. The higher the odds ratio value, the higher the predictors may contribute to the risk of falling.

Moreover, referring to the Table 3, it illustrates that, all the predictors variables did not contribute significantly to the model (refer equation 1). Because of this situation, the odds ratio column has to be consulted to determine and rank the predictors that contribute to the high level of fall risk. For odds ratio value more than 1 (OR > 1), the higher the unit change in the predictor, the higher the probability of falling, while for odds ratio value less than 1 (OR < 1), the higher the unit change in the predictor, the lower the probability of falling for the participants.

Table 1: Participants' physical characteristic and socio-demographic profile according to age group

		Age Group		
		Young-old (65 – 74 years old) (n)	Mid-old (75-84 years old) (n)	Oldest-old (>85 years old) (n)
Zones	North	11	9	12
	South	11	11	20
	East	13	7	12
	West	44	44	18
Races	Malay	36	28	42
	Chinese	33	36	13
	Indian	10	7	7
Residency	Rural	33	23	35
	Urban	46	48	27
Living Arrangements	Nursing home	31	33	23
	Live with others	29	17	24
	Living alone	19	21	15
Socioeconomic Status	RM 1000 and below	32	40	34
	RM 1001 – RM 2000	41	26	23
	RM 2001 – RM 3000	4	3	3
	More than RM 3001	2	2	2
Educational Attainment	Never attended school	16	22	18
	Primary level	16	25	16
	Secondary level	43	20	27
	Tertiary level	4	4	1
Present Marital Status	Single	4	1	2
	Married	43	34	39
	Widow/Widower	30	35	17
	Divorcee	2	1	4
Level of Fall Risk (OSI)	Low Risk	42	9	0
	High Risk	37	62	62

Table 2: Logistic regression predicting likelihood of determining the intrinsic factors based on level of fall risk

	B	S.E.	Wald	*df*	*p*	Odds Ratio (OR)	95% C.I for OR	
							Lower	Upper
Medical condition	2.364	.961	6.051	1	.014*	10.634	1.617	69.950
Medication	-.496	.518	.914	1	.339	.609	.221	1.682
Sensory	-1.314	.517	6.455	1	.011*	.269	.098	.741
Fall history	-.382	1.001	.146	1	.703	.682	.096	4.856
Mental status	-1.161	.801	2.100	1	.147	.313	.065	1.506
Physical activity	-.146	.625	.054	1	.816	.865	.254	2.942
Mobility limitation	1.781	.758	5.525	1	.019*	5.936	1.344	26.208
ADL difficulties	.605	.512	1.393	1	.238	1.831	.671	4.997
Age	.310	.053	34.036	1	.001*	1.363	1.228	1.512
Constant	-20.886	3.521	35.180	1	.001	.000		

**Significant level ($p < .05$)*

Table 3: Logistic regression predicting likelihood of determining the extrinsic factors based on level of fall risk

	B	S.E.	Wald	*df*	*p*	Odds Ratio (OR)	95% C.I for OR	
							Lower	Upper
Home access	.498	.473	1.107	1	.293	1.646	.651	4.162
Lighting	-.478	.638	.560	1	.454	.620	.177	2.167
Bathroom	1.785	1.069	2.787	1	.095	5.958	.733	48.427
Ground surface (outdoor)	-.742	.444	2.784	1	.095	.476	.199	1.138
Ground surface (indoor)	.398	.601	.438	1	.508	1.489	.458	4.838
Furniture	-.624	.454	1.892	1	.169	.536	.220	1.304
Activity related	.080	.575	.019	1	.889	1.083	.351	3.344
Constant	1.070	.269	15.767	1	.000	2.916		

**Significant level ($p < .05$)*

DISCUSSION

Falls are common phenomena among older adults with older females having more tendencies to fall compared to older males (Ratio 2:1). This is because; women usually expand greater postural sway. Falls also can be classified as 'geriatric giants' because it involves several intrinsic and extrinsic factors (Suzuki, 2003). The overall purpose of this study was to determine the predictors in intrinsic and extrinsic factors that could be the main contributor to the risk of falling. There are many distinct reasons for fall cases among older population, as listed in Table 2 and Table 3, which summarizes data from four zones in Peninsular of Malaysia. From the findings it shows that, falls usually occurred because of the intrinsic factors which are age and disease but not from other environmental hazards (extrinsic factors). The result from the current study has confirmed the previous findings that those who are older and experience three or more diseases are more likely to have tendency to fall. This is also consistent with the study by Steven & Soglow (2005). However, the intake and the quantity of the medication or drug therapy did not expose as a strong contributor to the risk of falling, which contradicted with the previous study (Grisso, Kelsey, & Storm, 1991; Tinetty, Speechley & Ginter, 1988; Granek, Baker & Abbey, 1987; Prudham & Evans, 1981). Numerous of the studies have stated that, there are a lot of pharmalogical effects of drug therapy such as drowsiness, confusion, dizziness, fainting or extremely weakness and were expected to lead to the risk of falling. In relation to the statement given, there is strong evidence that withdrawal from taking of the medication may reduce the risk of falling (Lord, Sherrington, Menz, & Close, 2007). Since the current study only focused on 212 participants, it is recommended to add on more participants in the future study to reconfirm the contradiction appears between quantity of the medication and the risk of falling. Besides that, sensory deficit factors demonstrate as one of the main contributors to the fall risks. This is because of the sensory information for balance usually comes from our eyes, vestibular (inner ear) and somatosensory or the sensation feeling in the legs. All of the sensation feelings from our sensory, vestibular and somatosensory may reduce in line with increment of age. Cataract, glaucoma, visual acuity, light phobic are the example of the symptom of sensory deficit and may contribute to high risk of falling (Ivers, 1998; Jack, 1995). Most of the participants having certain disease such as arthritis, therefore lead to significant result of mobility limitation factors. Overall, most of the research participants live and practice a sedentary lifestyle which could increase the risk of falling. From the model of equation, it could be conclude that older adults with more than three fall risk factors are having high risk of falling.

Implications of research findings and area of future research

The combination of Fall Risk Documentation Form and Biodex Balance System SD (BBS) device are quick and valid methods for screening the fall risk index among older population. In the practice of fall preventions program, the orthodox method to identifying 'at risk' individual by looking at some testing procedure is time consuming but our study introduce the more useful method. Besides that, it would be valuable to take into consideration to focus more on the interaction of socio-demographic and fall risk factors based on level of fall risk among older population for future research.

ACKNOWLEDGEMENTS

Our sincere gratitude is extended to the personnel of the Research Management Institute (RMI), UiTM, for administering the funds for the study and also all the research participants who devoted their valuable time to enthusiastically and patiently answer the questionnaire and commit with all the testing procedures. For unending support, we would like to express our deepest gratitude to Associate Professor Dr. Mohd Khairi Bin Zawi for providing us with the fundamentals needed and also creating a congenial academic environment that nurtures and sustains research. Your valuable advice and comments have been instrumental in developing our critical thinking. Finally, thanks to all individuals and non-individuals who had been involved either directly or indirectly in providing us with encouragement and help. We really appreciate all the supports, understanding, help, encouragement and humour throughout this long and challenging endeavour.

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Effect of Community Intervention on Physical Ability and Social Support among Elderly in Pasir Puteh, Kelantan

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Abstract

Physical activity may delay or prevent many of the physical and psychological problems that commonly occur with aging. Besides, social support is associated with increased physical and psychological health among the elderly. The objective of this study was to compare the physical ability and the social support score pre and post intervention among elderly in Pasir Puteh, Kelantan. A total of 56 participants aged 60 and above were recruited and involved in a community intervention study conducted in Kampung Banggol Jenerih and Kampung Berangan Pasir Puteh, Kelantan from December 2011 until February 2012. Their functional and physical abilities during pre and post three-months intervention were assessed using Barthel Index (BI) questionnaire and Short Physical Performance Battery (SPPB) physical examination. Social Support Questionnaire (SSQ) was also administered. Each of the participants was individually coached with eight simple steps indoor exercise. The exercise posters and calendars were left on the wall for their reference. A religious talk and interactive telematch were concurrently conducted for all the villagers (including the youngsters) to enhance their social support system. Descriptive analysis and paired t-test were performed using PASW 18.0. All the participants were Malay with mean (SD) age of 71(9.3) years old. Majority were currently not working (71.6%) and almost two-fifth (43.2%) were widow. The functional ability was significantly increased by 3.50 score (95% CI: 2.52, 6.75; p=0.035) post-intervention. Similarly, the physical performance score showed an increased trend but marginally insignificant (p=0.058). The social support score was statistically increased after intervention by 5.56 score (95% CI: 0.28, 11.08; p=0.049). Improving functional performance in elderly is important for their independence. Higher level of social support among elderly results in better compliance to the intervention program. There were significant increased in physical functional ability and social support among the elderly post intervention. A further follow-up is recommended to ensure the sustainability of the intervention program.

INTRODUCTION

Physical activity may delay or prevent many of the physical, psychological and cognitive problems that commonly occur with aging (Chodzko-Zajko *et al*., 2009). An intervention that improves the physical performance may also offer benefit on more health related outcomes in elderly, such as improvement on functional capacity (Nelson *et al.*, 2004; Pahor *et al.*, 2006; Vries *et al*, 2012) and reduction in chronic disease risk (Chodzko-Zajko *et al*., 2009).

Randomized controlled trials in older persons have shown that structured high intensity physical activity interventions, especially resistance and endurance exercises, improve a variety of physical performance measures (Vries *et a*l., 2012). A study by Pahor *et al.* (2006) showed that structured physical activity intervention improved the Short Physical Performance Battery (SPPB) score and other measures of physical performance. A previous study also has shown that home based physical activity intervention would improve physical performance of elderly. A study by Nelson *et al.* (2004) demonstrated that there was an improved Physical Performance Test (PPT) and The Elderly Short Physical Performance Battery (EPESE) in intervention versus the control group.

On the other hand, social support is also important in daily activities of the elderly. Several studies have provided evidence of association between social support with increased physical (Yuan *et al.*, 2010), psychological health (Booth *et al.*, 2000) and cognitive function (Yeh and Liu, 2003) among the elderly. Enhancing social support may be an important aspect of interventions aimed at increasing physical activity in a population (Eyler *et al.*, 2002).

Although the participation in physical activities is related to many health benefits, studies have indicated high prevalence of inactive elderly people in different countries around the world (Guthold *et al.*, 2008). Group based or community healthy lifestyle approach has been shown to be sustainable which improves the quality of life among elderly. However, an effective intervention in elderly should be tailored to their capability, needs and commitment.

A community survey in two rural villages in Pasir Puteh district, Kelantan conducted earlier in June 2011 revealed high proportion of elderly which is 19.1% versus 8% national data (Institute for Public Health, 2008). The survey showed high prevalence of the elderly also presented with obesity (Body Mass Index $\geq$ than 30 kg/m^2); 37.8% versus 14.1% national data (Institute for Public Health, 2008) in the two villages. The survey was conducted by Community and Family Case Study (CFCS), Group I, Year 3, academic session 2011/2012. CFCS is a community based program for undergraduate Degree of Medicine training at the School of Medical Sciences, Universiti Sains Malaysia (USM). In Phase Two (Year 2 and 3), students were placed in selected operational areas for them to identify, assess the community problem and undertake appropriate intervention activities. Overcoming problem of obesity in this local elderly group requires a longer duration and structured program. Hence, physical indoor exercise deemed suit to their lifestyle. Furthermore, social support may enhance the participants' response and compliance.
Therefore, the objectives of this community study were to compare the physical ability pre and post indoor exercise and also to compare the social support score pre and post social support activities among elderly in Pasir Puteh, Kelantan.

METHODS

Research Design

A community intervention study was conducted in two villages: Kampung Banggol Jenerih and Kampung Berangan in Pasir Puteh, Kelantan, from December 2011 until February 2012. The subjects included in this study were elderly, aged 60 years and above. Those who had bedridden, abnormal posture, physically handicapped, or hearing problem were excluded from the study. Universal sampling method was applied to select the eligible elderly. The largest sample size calculated was 70 subjects.

Method of Intervention

The intervention given to the elderly in this study were an indoor exercise program. Each of the subjects was individually coached with eight simple steps indoor exercise to be conducted twice a day using two mineral water bottles and a chair. The exercise was adapted from National Institute on Aging America exercise guideline (National Institute on Aging, 2004). Each steps need seven repetitions of movement. The respondents were advised to recite the zikr for each repetition. The exercise posters and calendars were also left on the wall for their reference. Social support activities which were concurrently conducted for all villagers comprises a religious talk that emphasize on respect, support and care for parents/elderly as well as an interactive telematch.

Definition of Outcomes and Research Tools

In this study, physical ability refers to physical performance which was physically assessed and functional ability was based on reported daily routine ability. Social support was defined as support by spouses, families, friends or local communities.

Subjects' functional and physical abilities during pre and post three-months intervention were assessed using Barthel Index (BI) Questionnaire and Short Physical Performance Battery (SPPB) physical examination. Social Support Questionnaire (SSQ) was also administered. SPPB physical examination was used to measure the lower body physical performance of the elderly such as walking, balance and repeated chair stand tests (Guralnik *et al*., 1994; Guralnik *et al*., 2000) and BI Questionnaire was used to assess daily routine functional status (Mahoney, 1965). SSQ was used to assess the social support status of the subjects (Sarason *et al*., 1983) during pre and post intervention. Both the questionnaires were self-administered.

Statistical Analysis

All statistical analyses were performed using the PASW version 18.0 software. The data was first analyzed using descriptive statistic to describe socio-demographic characteristics. Results were presented as mean and standard deviation (SD) for numerical and normally distributed data. For categorical data, results were presented as frequency and percentage

(%). Paired t-test was used to determine the difference of functional ability, physical performance and social support scores during pre and post intervention. All the statistical significance was accepted at *p* less than 0.05.

RESULTS

Socio-Demographic Profile of Elderly

A total of 56 subjects aged 60 and above were successfully recruited, which giving a response rate of 80.0%. All the subjects were Malay. The mean (SD) age of the subjects was 71.0 (9.30) years. Majority of them were currently not working (71.6%) and almost two-fifth (43.2%) were widow.

Comparison of Pre and Post Functional Ability and Physical Performance Score

Table 1 shows the comparison of daily routine functional status and physical performance before and after the intervention. The functional ability was significantly increased by 3.50 score (95% CI: 2.52, 6.75; p=0.035) post-intervention. Similarly, the physical performance score showed an increased trend but marginally insignificant (p=0.058).

Table 1: Comparison of physical ability pre and post intervention (n=56)

Outcome	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean difference (95% CI)	*t* stat	*p*-value[c]
Daily routine functional status[a]	91.0 (11.98)	94.5 (8.23)	3.50 (2.52, 6.75)	-2.158	0.035
Functional performance[b]	7.1 (2.62)	7.8 (3.07)	0.76 (-1.54, 0.03)	-1.938	0.058

[a] Barthel Index (BI) Questionnaire
[b] Short Physical Performance Battery (SPPB) examination
[c] Paired *t*-test

Comparison of Pre and Post Social Support Score

The difference of social support score pre and post intervention is presented in Table 2. The social support score was statistically increased after intervention by 5.56 score (95% CI: 0.28, 11.08; p=0.049).

Table 2: Comparison of social support score pre and post intervention (n=56)

Outcome	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean difference (95% CI)	*t* stat	*p*-value[b]
Social support[a]	71.1 (16.25)	76.7 (12.54)	5.56 (0.28, 11.08)	-2.013	0.049

[a] Social Support Questionnaire (SSQ)
[b] Paired *t*-test

Adherence sub-analyis

About 91.2% of the elderly claimed still practicing the exercise on post intervention. Mean (SD) of steps could be performed post intervention (maximum 8 steps) were 7 (2.0) with poster and 5 (2.8) without poster.

DISCUSSION

This study had evaluated the effect of a short-term community intervention on physical ability of rural Malay elderly population in Kelantan. Additionally, social support activities were conducted and assessed concurrently.

The physical ability of elderly in this study after three months revealed improvement with slight significance. A longer duration and more structured home-based exercise program results in better statistical significance of functional ability. For example, Nelson *et al.*, (2004) demonstrated that there was improvement of functional performance in 70 elderly people after a six month structured home based exercise program. The single blinded randomized controlled trial showed that there were improved Physical Performance Test (PPT) by 6.1 ± 13.4% in exercisers and decreased by 2.8 ± 13.6% in control group (p = 0.02). The Elderly Short Physical Performance Battery (EPESE) also showed significant improvement by 26.2 ± 37.5% versus decreased by 1.2 ± 22.1% in controls (p = 0.001). However, a meta-analysis on effect of physical exercise concluded that even a short three months intervention demonstrated a positive effect in physical functioning on older adults with impaired mobility and physical disability compared to longer duration of more than 3 months (Vries *et al.*, 2012).

The positive physical activity effect in the present study was contributed by adherence of the subjects on the indoor exercise. A simple, minimally supervised and safe physical activity intervention could successfully improve the physical performance of elderly group (Nelson *et al.*, 2004) and ensures sustainability. The current respondents were found to be comfortable with the recommended exercise regime using two mineral water bottles and chair which were affordable and easily available. Furthermore, the steps were simple and manageable. The evidence of sustainability based on sub-analysis revealed that majority of the elderly still practicing the exercise on post intervention. The respondents were able to

remember even in average five out of the eight steps without referring to the exercise poster provided.

In addition, other environmental influences namely opportunities to conduct the physical activity and family support further promotes the continuing physical activity habit among the rural older adults (Booth *et al*., 2000). In Malay culture, the elderly or retired people in rural live as extended family, spend a lot of time socializing with close neighbours and attend religious activity. Exercise is not their routine, especially the females. However, the respondents were committed with the intervention probably because it suits their lifestyle and norms. The activity was designed as an indoor exercise. It was incorporated with recite for each movement. A faith based related physical activity intervention was suggested as an appropriate approach for increasing physical activity among adults (Whitt-Glover *et al*., 2008).

The social support score was marginally significantly increased in post-intervention. The primary aim of integrating social support activities into the older people exercise environment was to enhance their adherence and ensure sustainability (McAuley *et al.,* 2000; Nelson *et al.,* 2004). Elderly people are more likely to be physically active when they were supported or accompanied by family members (Booth *et al*., 2000; Yuan *et al.*, 2010). The contribution of spouse, family and peer include participated together with the elderly in physical activity, gave them helpful reminders, encouraged them to be active or took over chores to allow them to be active (Booth *et al*., 2000).

Strengthening family relationships may reduce the prevalence of chronic diseases among these senior citizens. Improving functional performance in elderly is important for their mobility, independence and prevent further poor health outcomes (Rolland *et al.*, 2006; Volpato *et al.,* 2010). Promoting physical activity in elderly can facilitate healthy aging and essential in reducing future healthcare expenditures.

This study has certain limitations that should be recognized. The samples were not randomized and also no control group was considered in this study. The duration of follow-up was short which only three months. The Malay version of BI Questionnaire and SSQ were only content validated and no rater agreement assessment was done prior to the actual study.

CONCLUSION

Home based exercise program was feasible, practical, effective and could improve functional performance in local elderly individuals despite limited supervision. Social support may contribute to increase adherence of healthy behavior in elderly. A further follow-up is recommended to ensure the long-term effect and sustainability of the intervention program.

ACKNOWLEDGEMENTS

I would like to acknowledge the members of CFCS Group I (PBL 6 & 14), Year 3, 2011/2012 Medical students, namely Prehmanraj A/L Mariyapan, Zainal Hisham Bin Burhanuddin, Ong Kai Ping, Mohamad Fuad Shah Bin Mohd Damanhuri Shah, Nadia Nurul Amirah Binti Ahmad Fuad, Nur Aqma Binti Muhammad Farid Wong, Nor Amalina

Binti Khairil Anwar, Nor Hasnida Binti Nawi, Siti Zulaikha BInti Zakaria, Razan Hayati Binti Zulkeflee, Kam Zhi Yuan, Nur Syazana Binti Kamarulzaman, Mohammad Rizal Bin Mohamad Ridzuan Wong, Lim Pek Sern, Joyce Fong Ler Sim, Nurul Ezzah Binti Ahmad, Azianty Binti Azizan, Koay Zhi Shuang, Shanti A/P S. Mugunen, Vivian Ooi Sheen Yue, Mohd Faizal Bin Md Jenal and Nuruladila Binti Hassim for their effort in conducting the study. A special thanks to the USM Knowledge Transfer Program (KTP) Grant for supporting this study. A warm gratitude to Penghulu (Nik Yusoff Nik Abdullah and family), Tok Imam, and villagers of Kg. Berangan and Kg. Banggol Jenerih, Pasir Puteh, the CFCS, USM Secretariat for helping in conducting the study and Mrs. Siti Nor Ismalina binti Isa for arranging and assisting in the manuscript writing.

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The Effects of Computerized Neuromuscular Control Training on Athlete's Dynamic Postural Control Ability

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Abstract

Balance is an important element of almost all sports activities and activity daily living (ADL). Balance can be measured based on individual postural control which consisted of static, semi-dynamic and dynamic. These aspects were controlled by neuromuscular and reduction in the neuromuscular ability due to injury such as patellofemoral pain syndrome (PFPS) may alter the postural control ability. The aim of this study was to investigate the effects of neuromuscular control training on athletes with PFPS. In this study, there were 27 athletes with PFPS (male= 22, female = 5; mean age= 14.59 ± 1.28 years, height = 161.96 ± 7.85 cm, weight = 54.93 ± 11.42 kg and Body Mass Index (BMI) = 20.65 ± 2.20) voluntarily took part in 8-week of computerized neuromuscular control training (CNCT) program. The Y-Balance Test was used for assessment of athlete's dynamic postural control (DPC). A doubly multivariate analysis of variance was performed on two measures of the test (pre and post test) over three (3) dynamic postural control (DPC) characteristics between groups. This analysis was performed in order to identify the interaction and main effects of the intervention (CNCT) to subject's dynamic postural control (DPC). An 8-week of computerized neuromuscular control training (CNCT) program resulted significant changes in all aspects of dynamic postural control (DPC). It showed that CNCT program significantly enhanced athlete with PFPS's DPC ability in terms of anterior ($F(1,25) = 14.037$, $p = 0.001$, $\acute{\eta} = 0.260$), posteriolateral direction ($F(1,25) = 13.774$, $p = 0.001$, $\acute{\eta} = 0.355$). and posteriomedial direction ($F(1,25) = 11.318$, $p = 0.002$, $\acute{\eta} = 0.312$). This study suggested the physician and coaches should emphasize more on neuromuscular training for athlete's with PFPS since the PFPS may reduce the athlete's performance especially in sports that require dynamic postural control.

INTRODUCTION

Balance is an important element of almost all sports activities and activity daily living (ADL). Balance can be measured based on individual postural control which consisted of static, semi-dynamic and dynamic. The maintenance of this complex process depends on the vestibular system, age, pain, vision, body shape, visual-spatial perception, tactile input, agility, proprioception and the musculoskeletal and neuromuscular system (Jones & Barker, 2000). These aspects were controlled by neuromuscular and reduction in the neuromuscular ability due to injury such as patellofemoral pain syndrome (PFPS) may result in imbalance.

For individual who experienced patellofemoral pain syndrome (PFPS) or usually referred as runner's knee the symptoms may cause 74% of them to limit sport activities or lead to sports cessation (Blond & Hansen, 1998). The symptoms of PFPS are generally due to the loading on the knee during flexed position such as walking up and down stairs, squatting or rising from a seated position and the patients generally complain of restriction of gait (Powers, 2000). The symptoms also occur when the patients sit for a long time with the knees flexed (McConnell, 1986). Individuals with PFPS will try to reduce the irritation of the symptoms by adjusting their gait and other activities by decreasing their patellafemoral reaction joint force (PFJRF). Common compensation movements includes decrease knee flexion during stance phase of gait, reduce walking velocity and leaning the trunk anteriorly during stair ambulations (Salsich *et al*., 2002). All of these gait adjustment might change their postural balance thus increase more serious knee injuries.

To date, a number of approaches to physiotherapy management for PFPS have been proposed to alleviate pain through restoration of patellar alignment via use of interventions like muscle strengthening exercises, stretching, patellar taping, bracing, orthoses, manual therapy, electric stimulation and EMG biofeedback (Crossley *et al*., 2002). However, studies showed that approximately 25% of patients continue to have pain and dysfunction for more than one year after physiotherapy has been completed (Piva *et al*., 2009).

It seems that restoring patellar alignment is still not enough for a functional recovery among PFPS patients because neuromuscular controlling mechanism is required during daily living and sports specific activities (Williams *et al*., 2001). Therefore, both mechanical stability and neuromuscular control are important for long-term functional outcome, and both aspects must be considered in the design of PFPS rehabilitation program.

Based on mechanical stability and neuromuscular control theories and measures relevant construct described above, the study sought to investigate the dynamic postural control (DPC) aspect of athlete with PFPS and the effectiveness of an intervention program (neuromuscular control training) towards intervention group.

METHODS

Subjects

Subjects were recruited using via contact details given by physiotherapist in Tunku Mahkota Ismail Sports School, Kota Tinggi, Johor, Malaysia The inclusion criteria were set as follows: age within the range of 13 to 19 years old, participated in the inter-state level for at least one year, experienced anterior knee pain surrounding the patella or in the sub-patella region for more than four weeks, insidious onset of symptoms unrelated to a traumatic event, pain from at least two of the following activities commonly associated with PFPS: prolonged sitting, ascending or descending stairs, squatting, kneeling, running, hopping or jumping (Crossley *et al*., 2002) and identified as PFPS patient by qualified physician. Oral and written explanations of the study were offered to the participants. Subjects were excluded if they had one of the following exclusion criteria: chondromalcia patella (degeneration or damage of the patellar cartilage based on Scuderi & Tria (2010),pain due to palpation along the quadriceps tendon or patellar ligament, medial plica snapping sensation, signs and symptoms of meniscal or articular cartilage pathology, knee joint effusion, history of patellar subluxation or dislocation, history of osteoarthritis, history of neurological impairment, ligament laxity, history of Osgood-Schlatters and history of

Sinding-Larsen-Johanson syndrome. Based on (Swanson, 2009) the patients who suffered from any of the followings in the area of joint; tumors, bone infections, traumatic injuries or metabolic disorders are unable to be adjusted if they were given the treatment of PFPS.

Subject Randomization

Randomization via computer-generated random numbers was performed in blocks of two subjects stratified based on first sign up for subjects list. There were 27 subjects and they were randomly assigned to the intervention group (n = 14) or the control group (n = 13).

Intervention

The intervention group went through normal training routine from their coach and 16 sessions of one hour of computerized neuromuscular control training program within eight weeks. The control group did not receive any intervention but were simply instructed to spend their normal training routine from coach during the intervention phase. In order to avoid contamination during the intervention period, the neuromuscular control training location was set at a place where the subjects in the control group were not usually visit when the training session was on.

Warm-up and Stretching

Before training, subjects participated in warm-up and stretching exercise consisting of 10 minutes walking on treadmill and dynamic stretching on calf, hips and quadriceps such as kick leg side, kick leg behind, mini squat, rise up toes and heels. These dynamic stretching exercises were performed for three sets with eight repetitions each. These warm-up and stretching exercises were targeted on lower leg muscles.

Computerized Neuromuscular Control Training (CNCT) Program

Computerized neuromuscular control training program consisted of preprogrammed training mode (Chase Trainer-CT) which required subject to stand with both foot on Balance Trainer platform (BT3, HurLab, Tampere, Finland) and shifting their weight anterior-posterior and lateral-medial direction guided by diagram in computer screen (Figure 1). In this training mode, subject was instructed to maintain their shifting position (red line) in the blue circle as it moved and needed to complete a sequence of nine (9) conditions as programmed by the researcher. Each condition required the subject to shift their weight for 60 seconds. The score was displayed on the screen based on the percentage of time subject spend on the blue area. If the subject could not reach the minimum 70 percent of score, the training was terminated in order to prevent more serious injuries.

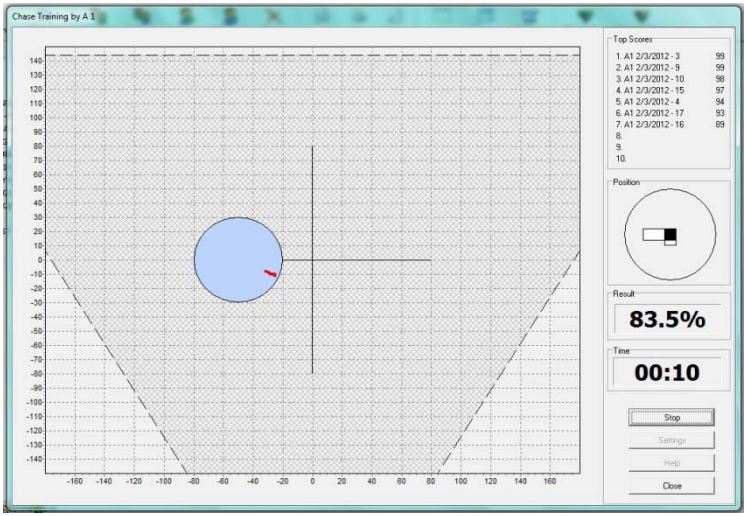

Figure 1. Diagram of Screen for Chase Trainer in Balance Trainer (BT3, HurLab, Tampere, Finland)

Testing Procedures and Protocol

The experimental period consisted of two blocks of testing over eight weeks, with at least one familiarization session. Subjects in intervention group underwent their daily training routine and computerized neuromuscular control training after the familiarization session meanwhile subject in control group underwent only their daily training routine. Measurement (post-test) were taken prior to eight weeks of first measurement (pretest) were taken.

Dynamic Postural Control (DPC) using Y-Balance Test

The pre and post of standardized measurement protocol of Dynamic Postural Control (DPC) was proposed using Y-Balance Test **(Figure 2).** The subjects were requested to perform one leg stand (injured leg) in the middle of the testing grid and reach as far as possible with another leg (non-injured leg) in three directions on the grid (anterior, posteriomedial and posteriolateral). These directions had been considered sensitive to functional deficits related to lower limb injury with intraclass coefficients of correlation (ICC) between 0.88 to 0.99 (Plisky et al., 2009).

Prior to testing, subjects were given two practices trials in three reach directions. After the subjects completed the practice trial in all three directions, the subjects were given one minute rest before the formal testing begins. During the formal testing, subjects need to perform three set of trials in each of the three reaching directions at random order. Subjects need to stand on one leg (injured leg) in the center of the grid with the most distal aspect of the toe at the beginning of the line. Subjects were encouraged by the researcher to reach as far as possible with another leg (non-injured leg), lightly touch their toe on the line, and return their foot back to the stance leg. They were required to keep their hands on their hips throughout the entire test. The subjects need to repeat the trial if they failed to maintain a

unilateral stance, lifted or moved the stance foot, touched down with the reach foot, or failed to return the foot to the starting position.

The reach distance was measured and recorded by the researcher using measurement tape. The average of the reach distances were recorded in millimeters and normalized to leg length. This was done by dividing the reach distance by the subject's leg length and converting to a percentage for each of the three reach directions.

(a) (b) (c)

Figure 2: Direction of Y-Balance Test: (a) Anterior (b) Posteriomedial (c) Posteriolateral

STATISTICAL ANALYSIS

The descriptive data are presented as means and standard deviation. Prior to neuromuscular training, a MANOVA was used to determine whether differences existed between intervention and control groups. For all procedures, significance was accepted at the alpha level of 0.05.

RESULT

Study population

Our initial pool of study subjects comprised 30 athletes who experienced PFPS from Tengku Mahkota Ismail Sports School, Kota Tinggi, Johor, Malaysia. However two (2) refused to participate and one (1) did not meet the inclusion criteria. The remaining 27 athletes (male= 22, female = 5; mean age= 14.59 ± 1.28 years, height = 161.96 ± 7.85 cm, weight = 54.93 ± 11.42 kg and Body Mass Index (BMI) = 20.65 ± 2.20) agreed to participate in the study and provided written consent.

Adherence to the study protocol

During the 8-week intervention phase, 16 exercise sessions were scheduled and all took place. The intervention group subjects attended an average of 15 sessions and had an overall attendance rate of 93% over the 8 weeks. No injuries problems occur during the sessions except complaining from subject regarding tiredness due to hard training from their coach. The neuromuscular control training session or testing were rescheduled to more appropriate time.

Baseline characteristics

The baseline data for 27 subjects who completed the study were summarizes in Table 1. No significant differences between the intervention and control groups were observed in all variables except in dynamic postural control for posteriomedial direction.

Table 1. *Baseline Characteristic (mean ± SD) of Subjects*

Variable	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	*p* value
Age (years)	14.93 ± 1.33	14.23 ± 1.17	0.161
Height (cm)	163.93 ± 4.86	159.85 ± 12.74	0.275
Weight (kg)	55.85 ± 6.78	53.92 ± 15.19	0.669
Body Mass Index	20.70 ± 1.57	20.59 ± 2.80	0.893
Dynamic Postural Control			
Anterior	90.82 ±8.02	84.41 ± 15.51	0.185
Posteriomedial	97.20 ± 26.08	46.19 ± 441	0.000*
Posterolateral	59.64 ±11.54	70.11 ± 12.43	0.035

*Significant at $p<0.05$ level.

Effects of Intervention

After 8-weeks of intervention phase, the data of dynamic postural control (DPC) were analyzed using MANOVA in order to determine the effect interaction and main effects) of the intervention (CNCT) on subject's dynamic postural control. The details of the interaction and main effects are shown in Table 2 and Table 3. Due to unequal number of subjects between the groups, only Pillai's Trace analysis were used (Tabachnick & Fidell, 2001).

Using the Pillai's Trace criteria, the between group interactions, as seen in Table 2, deviated significantly from parallelism at $F(3,23) = 90.349$, $p = 0.000$, $\acute{\eta} = 0.922$. This significant was also seen within subjects between trial (pre and post) at $F(3,23) = 27.098$, $p = 0.000$, $\acute{\eta} = 0.779$. The groups by test interaction (deviation from parallelism) also was strong and statistically reliable with multivariate $F(3,23) = 11.950$, $p = 0.000$, $\acute{\eta} = 0.609$. This indicated the interaction between the intervention (CNCT) effects were statically significant within and between groups. In order to identify the main effects of intervention (CNCT) the details was shown in Table 3.

Table 2. Interaction effects of the intervention (CNCT)

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Between subjects	Group	Pillai's Trace	.922	90.349[a]	3.000	23.000	.000	.922
		Wilks' Lambda	.078	90.349[a]	3.000	23.000	.000	.922
		Hotelling's Trace	11.785	90.349[a]	3.000	23.000	.000	.922
		Roy's Largest Root	11.785	90.349[a]	3.000	23.000	.000	.922
Within Subjects	trial	Pillai's Trace	.779	27.098[a]	3.000	23.000	.000	.779
		Wilks' Lambda	.221	27.098[a]	3.000	23.000	.000	.779
		Hotelling's Trace	3.535	27.098[a]	3.000	23.000	.000	.779
		Roy's Largest Root	3.535	27.098[a]	3.000	23.000	.000	.779
	trial * Group	Pillai's Trace	.609	11.950[a]	3.000	23.000	.000	.609
		Wilks' Lambda	.391	11.950[a]	3.000	23.000	.000	.609
		Hotelling's Trace	1.559	11.950[a]	3.000	23.000	.000	.609
		Roy's Largest Root	1.559	11.950[a]	3.000	23.000	.000	.609

a. Exact statistic

Table 3. Main effect interaction of the intervention (CNCT)

Source	Measure	trial	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
trial	Anterior	Linear	158.852	1	158.852	12.155	.002	.327
	Posteriomedial	Linear	758.733	1	758.733	5.036	.034	.168
	Posteriolateral	Linear	9826.580	1	9826.580	69.227	.000	.735

*significant at $p < 0.05$

As seen in Table 3, the main effects of computerized neuromuscular control training (CNCT) on athlete with patellafemoral pain syndrome (PFPS) were not significantly enhanced in all aspects of dynamic postural control. It shown in posteriomedial direction where the $F(1,25) = 5.036$, $p = 0.034$, $\eta = 0.168$. However for other aspects of tested dynamic postural control elements, it had shown a statistically significant.

DISCUSSION AND CONCLUSION

Individuals with PFPS generally have anterior knee pain that is exacerbated by knee loading activities. The results of this study provided evidence that partially supportive of the study hypothesis that dynamic postural control in all direction (anterior, posteriomedial and posteriolateral) in Y-balance test would increase after neuromuscular control training. The study revealed that neuromuscular control training did not have significance impact in posteriomedial direction.

This finding suggests that the individuas with PFPS may be able to modify redundant muscle coactivation during the Y-balance test. This was supported by previous studies where symptomatic leg muscle had shown compensatory strategy in terms of muscle activation compared to asymptomatic leg muscle in order to maintain postural stability (Nagai et al., 2012). By increased the activation of antagonist or synergist muscle such as hamstring, vastus medialis, individual with PFPS be able to reduce or lessen the pain around patella (Stendotter *et al*., 2008).

Another explanation of why this result did not show any significant differences was limitation of this study which was baseline-matched control group. Since there was difference in posteriomedial direction between groups at baseline it influenced the outcomes. As supported by Assmann *et al*. (2000), if a baseline factor strongly influences outcome, a non-significant treatment imbalance may be important.

In conclusion, the intervention that been proposed (computerized neuromuscular control training using Chase Trainer in BT3) was effective and improved athlete with PFPS in other two aspects in dynamic postural control (anterior and posteriolateral). Based on this evidence, we recommend the use of this intervention for postural and neuromuscular control improvements. Given that these are desirable adaptations after injury or disease to prevent long-term functional restrictions; neuromuscular control training might be useful both in rehabilitation and for preventive purposes. Further research is needed to determine the efficacy and dose-response relationship of neuromuscular control training for functional performance improvements and postural control changes.

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The Effects of Combining Milk Supplementation and Aerobic Exercise on Short Term Memory in Secondary School Female Students

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Abstract

It has been suggested that dietary intake and physical activity independently contribute to the development of physical and mental functions of children. Therefore the purpose of this study was to examine the combined effects of milk supplementation and aerobic exercise on short term memory in secondary school female students. Eighty-one secondary school female students aged 16 years from four boarding schools within the district of Kota Bharu were recruited. Subjects were then randomly grouped into either one of the three intervention groups (milk, exercise or combination of milk and exercise) or the control group. Milk supplementation was provided to students during schooling days for six weeks. A one-hour aerobic exercise was conducted for two times a week for six weeks. The combined group received both the milk supplementation and aerobic exercise. Short term memory was measured using Digit Span Test before and after the intervention. The results revealed a significant interaction between groups across the testing sessions. No difference was observed between the groups at pre intervention. However, at post-test, the combined group performed significantly better than the milk group (mean difference=2.171, p=0.016) and the control group (mean difference=3.189, p=0.001). There was no difference between the combined group and the exercise group (mean difference=0.039, p=0.966). Furthermore, there was no significant difference between milk group and control group (mean difference=1.017, p=0.238). The results underscore the importance of regular moderate to vigorous intensity exercise to student short term memory. Twelve one-hour sessions seemed to improve student short term memory. Combining milk to exercise regime did not provide any additional benefits in terms of short term memory. Milk alone did not improve student's short term memory.

INTRODUCTION

Cognition is a term typically described human information processing and memory (Davis & Lambourne, 2009) which are important to learning. Information processing requires the selection of focussed information by perception and the elimination of the unwanted information. Selection depends on the quantity of the selected information (attention span) and the speed and accuracy of selection (vigilance). The selected information is then

sustained on limited processing capacity and given meaning onto it prior processing. The information is then stored as memory.

Memory is basically grouped into two i.e. short-term memory and long-term memory. After selection, the information input stored into short-term memory. Following that, the information encoded and stored in long-term memory. When the information retrieved from the long-term memory, it again stored in the short-term memory (Gazzaniga & Heatherton, 2003). Better cognitive performance often inferred to have some effects on influencing academic performance of school children. Therefore, there were plenty of studies conducted to investigate the effect exercise and/or nutrition on cognitive. Exercise and/or physical activity and its health benefits were well-documented (United States Department of Health and Human Services, 2008). These include physiological benefits, psychological benefits and fitness improvement.

Rapid worldwide development causes sedentary lifestyle increasingly adopted over the past decades. Physically inactive among children and adolescents has transformed into a global issue including Malaysia. The habit of physically inactive may carry from younger age into adulthood and may lead to increased risk of future health problems such as cardiovascular diseases and metabolic diseases. It may also impact mental health. Physical activities aid in the enhancement of cognition development. Previous studies supported physical activity positively associated with better cognitive functioning among children. Sibley and Etnier (2003) conducted a study and reported positive correlation between physical activity and learning in a meta-analysis of school-aged children. Physical fitness, resulted from physical activity, was positively associated with cognitive performance among preadolescent children (Buck, 2008) and school age children (Sibley & Etnier, 2003; Tomporowski *et al.*, 2008). Higher fitness level may augment concentration (Chomitz *et al.*, 2009) in which may inferred slightly related to the enhancement of short term memory. Physical activity could improve cognitive efficiency by increase neurogenesis which is the growth of new nerve cells in the nervous system. A study conducted by van Praag and colleagues (2005) shown voluntary exercise and running stimulate hippocampal neurogenesis. Moreover, exercise stimulates angiogenesis i.e. the growth of new vascularity and hypertrophy of blood vessels within cerebral cortex (Kleim, Cooper & VandenBerg, 2002). It was suggested that greater perfusion of blood through this region may promote improvement of cognitive function.

Aerobic dances, a type of aerobic exercise involved the combination of hands and legs movement following rhythmic music is popular among females in recent decades. Aerobic dance provide several benefits such as positively affects cardiorespiratory capacity (Rockfeller & Burke, 1979) and reduce the potential of the development of cardiorespiratory disorder. Moreover, aerobic dance contribute to cognitive and emotional development. Music-based exercise programme enhanced cognitive development (Van de Winckel *et al.*, 2004). Aerobic dance positively improved specific dimensions of mood (McInman & Berger, 1993) and helped to reduce some of the physical symptoms of anxiety (Erwin-Grabner *et al.*, 1999). Additionally, aerobic dance enhanced body attitudes and physical self-perception (Burgess *et al.*, 2006) and lead to a positive shift in attitude.

On another hand, food also contributes to cognitive performance. Dairy products (for example milk) as situated in the food pyramid indicating its importance. It is essential throughout the life cycle especially during childhood and adolescence. However, milk consumption pattern shifted from childhood to adolescence. Milk consumption switched to less-nutritious beverages such as soda and fruit juice among young female (Bowman,

2002). Even milk consumption was declined but there was an increment in other dairy products (cheese and dairy desserts) intake (Fiorita *et al.*, 2006). Perception of milk as children's beverage (Bowman, 2002) and the increase awareness of body image among adolescents results in the shifting as well.

Previous studies investigating the effects of milk on cognitive performance showed positive results. Children drinking milk had a higher recall of memorized words and numbers (Lien do *et al.*, 2009). This improvement may infer that milk impacts on children's short-term memory. Long-term milk consumption improved attention and memory of children (Hu *et al.*, 2010). Moreover, daily milk supplementation enhanced physical and mental function among children especially among girls (Rahmani *et al.*, 2011). Additionally, taking milk as breakfast may affect cognitive performance. Breakfast enhance cognitive performance (Mahoney *et al.,* 2005) and benefited on memory functions such as recall, episodic memory and both short-term and long-term memory (Rampersaud *et al*., 2005). Hence, present study was proposed to investigate the inter-relationship among aerobic exercise, milk consumption and cognitive performance among secondary school female students in Kota Bahru, Kelantan, Malaysia.

METHODS

Research Design

An experimental pre-post test design was employed for the present study. Subjects were randomly assigned into 4 groups for 6-week intervention.

Subjects

Secondary school female subjects (N=81) aged 16 were recruited from four different boarding schools in Kelantan. Subjects were informed about the experimental design and protocol of the present study as well as the possible risks before giving informed written consent. They were then randomly assigned into groups i.e. (a) milk, (b) exercise, (c) combination of milk and exercise and (d) control group according to school.

Supplements

Dutch Lady® UHT Low Fat Milk (250ml) was used in the present study. It was supplemented to students. The milk was only given to students who were in the milk group and in the combination group during the 6-weeks intervention. Each student took the milk at specific time during schooling days within the 6-week intervention.

Procedures

Approval to conduct the study was obtained from Universiti Sains Malaysia (USM) Research and Ethical Committee, Ministry of Education of Malaysia and the principal of the participating schools. Following that, a short briefing session between the researchers' team and the participants was conducted to explain the details of present study. Research information was distributed to students along with an explanatory letter and informed consent form for the students and their parents or guardians.

Students who were interested to take part in this study with the consent given by both the students themselves and their parents or guardians were given a set of questionnaires to be completed. The set of questionnaire consisted of the individual sociodemographic questionnaire, Physical Activity Questionnaires for Older Children (PAQ-C), Food Frequency Questionnaires on dairy products and Physical Activity Readiness Questionnaire (PAR-Q). Students were guided to ensure they understood the questions. Additionally, students were given Digit Span Test (DST) along with the questionnaires. Anthropometry measurement was taken too during the meeting. The completion of the few questionnaires, tests and anthropometry measurement were for the purpose of screening the subjects.

Subjects who meet the inclusion criteria were included while those did not meet the criteria were excluded. Furthermore, this screening was performed to ensure that the groups did not differ significantly at the basis of their cognitive performance and physical activity level.

The four schools were then randomly assigned into the intervention and control conditions. Students in milk group were given 250ml milk supplementation at specific time 5 days per week for 6 weeks. Subjects in the exercise group participated in aerobic dance session twice a week for 6 weeks. Each aerobic dance session was one hour. Subjects in combined group were given 250ml milk supplementation as in milk group and attended aerobic dance session for one hour as in exercise group for 6 weeks. Subjects in control group did not receive any intervention. Instead, they were only included in the measurement sessions.

Parameters Analyses

The Digit Span Test (DST), based on Wechsler Memory Scale Third Edition (WMS-III), was presented in the forward sequence and backward sequence. Instructors read the sequence in the same tone with the gap in between each digit of about 1 second. The digits were increasing in length for every two trials attempt. Subjects were requested to memorize the presented digits and write it down on the paper provided.

For forward sequence and backward sequence, 1-point score was given for each correct trial. When there was any error within the digits' sequence in the trial, score was not given. Errors for the consecutive trials terminated the scoring. The scores accumulated for forward sequence and the backward sequence were added and be the total score for DST.

Statistical Analysis

Data were analysis using Statistical Package for Social Science (SPSS) version 18.0. Repeated Analysis of Variance (2-ways ANOVA) was performed to determine the differences between and within the groups. Statistical significance was at $p<0.05$. Data were reported in mean ± standard deviation for the measurement of Digit Span Test.

RESULTS

Analysis of 2 (sessions: pre- and post-intervention) by 4 (groups: control, milk, exercise, combination) ANOVA (Table 1) was used and revealed significance interaction between the experimental groups across the testing sessions ($F = 3.00$; $df = 5.112$; $p = 0.00$).
A simple effect was further computed to determine the pair-wise difference between groups across the testing sessions. The results revealed that combination group significantly different to the milk group ($p=0.016$) and to the control group ($p=0.001$) at post-

intervention. However, there was no significant difference between exercise group and combination group (p=0.966). Furthermore, there was a no significant difference comparing milk group to control group (p=0.238).

Table 1:- The scoring of Digit Span Test of the subjects. Values are means ± standard deviation.

Group	Pre-intervention	Post-intervention
Control	16.70 ± 3.29	16.20 ± 2.33
Milk	15.52 ± 4.08	17.22 ± 2.60
Exercise	15.90 ± 3.97	19.35 ± 3.08
Combination	17.28 ± 2.85	19.39 ± 3.17

DISCUSSION

Aerobic dance is an exercise which has the potential to improve fitness in an enjoyable and interesting way. Hence, it may encourage students to engage in healthy lifestyle. Aerobic dance provide several physiological benefits and mental health benefits in which would contribute to the cognitive performance. On another hand, nutrition has its role in cognitive development too. Milk is one of the dairy products which contain nutrients that are essential to cognitive performance. Milk supplementation improved physical and mental functions among children (Lien *et al.,* 2009; Rahmani *et al.,* 2011).

Findings from the present study revealed that there was significant difference between groups for short-term memory using Digit Span Test. Combination group significantly different to milk group and to control group. However, no significance difference was found when comparing exercise group to combination group. Meanwhile, milk group showed no significance difference to control group.

Several studies revealed positive relationship between physical activities on cognitive functioning (Sibley & Etnier, 2003; Tomporowski *et al.*, 2008). Present findings were parallel with previous study suggesting physical activity enhance cognitive performance. In line with the study of Ruscheweyh *et al.* (2011) suggesting physical activity benefits memory function, the present study revealed that exercise given improved students' short-term memory after 6-weeks intervention.

The impacts of physical activity and/or exercise on cognitive performances were often associated with the physiological changes in the brain specifically hippocampus (the brain region central to learning and memory) on vascularization (formation of new blood vessels), angiogenesis (development of new blood vessels) and neurogenesis (formation of the nervous system). The changes of the brain's structure and brain's neurochemistry have their roles of influence too. Cotman and Berchtold (2002) revealed that exercise promoted brain vascularisation and neurogenesis. Moreover, Uysal *et al.* (2005) found that regular aerobic exercise induced hippocampal formation and thus increased the potential for neurogenesis. This benefited memorizing capability.

Additionally, exercise improved brain function with the bases of physical activity increase systemic blood pressure and causing increment in the overall perfusion of the brain

(Herzholz *et al.*, 1987). Exercise was also found in increasing brain vascular density in relation with exercise (Rhyu *et al.,* 2010).

Since exercise is the primary action that enhances angiogenesis, data from Kerr *et al.* (2010) suggested that angiogenesis provoked beneficial effects on learning and memory performance. They proposed vascular supply and plasticity are critical factors to learning and memory. Metabolic availability may have the role on cognitive benefits. Furthermore, physical activity increased serotonin precursor tryptophan to be transferred across the blood-brain barrier and exerted calming effects (Trudeau and Shephard, 2010). This calming effect may benefits learning with suitable arousal. Hence, students may concentrate better and in turn affect their cognitive performance.

Alternatively, several studies shown milk supplementation improved cognitive functioning (Lien *et al.*, 2009; Rahmani *et al.*, 2011). Thus, it was expected that milk supplementation can improve short-term memory among students. However, the current findings were contrary to previous studies. Present study revealed that milk supplementation having no effect on the short-term memory. Children who drink milk have higher recall of memorized word and numbers (Lien *et al*., 2009). However, the present study was not supporting this. By referring to Lien *et al.* (2009) study, the nutrients of milk that used for supplementation in present study were different from their study. The amount of zinc in the milk supplied was 1.1mg in 100ml of milk in Lien *et al.* (2009) whereas milk that supplied in this study for the students was 0.4mg in 100ml. The difference on the amount of the major nutrient, zinc which is essential to memory, indicate that the amount in the milk supplied in the present study was not enough to improve short-term memory.

CONCLUSION

In the present study, we concluded that aerobic dance as an aerobic exercise significantly improved students' short term memory. Milk supplementation did not significantly affect short term memory of students. Combining milk to exercise regime (aerobic dance) did not significantly provide any additional benefits in terms of short term memory.

ACKOWLEDGEMENTS

We would like to thank Universiti Sains Malaysia for the grant used to support this study. We would also like to send our gratitude to all subjects who participated in this study and the cooperation given by the teachers and principal from the schools that participated in this study.

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The Association of rs9939609 Variant of the *FTO* Gene and Overweight Measures and Gender in Malay Children

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Abstract

The World Health Organisation defines obesity as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired. Besides lifestyle or environmental factors, genetic factors have been established as a strong influence on obesity. However, the relationship between specific polymorphisms and obesity in various populations is still being explored. This study attempted to investigate the association between the common rs9939609 variant of the FTO gene and overweight among Malay children. A total of 107 healthy Malay children between 9 and 12 years old were recruited from primary schools within Kota Bharu, Kelantan, Malaysia. Parameters measured in this study included height, weight, body mass index (BMI), waist circumference (WC), bioelectrical impedance analysis and presence of an rs9939609 polymorphism in the FTO gene. Based on the sequencing results, the polymorphism of the rs9939609 variant of the FTO gene was subsist in the Malay population. The minor A allele frequency (MAF) was 0.25. However, the results show no association between FTO rs9939609 polymorphism and BMI categories (p=0.9014), WC (p=0.6828) and body fat percentage (p=0.9011). Based on the statistical analysis performed, there was no association between gender and rs9939609 polymorphism (p=0.3345). It is possible that the low MAF in this study play a major role in producing such results. As a conclusion, this study found no significant association between the rs9939609 polymorphism of the FTO gene and overweight measures and gender but the rs9939609 polymorphism was present in the Malay population.

INTRODUCTION

The World Health Organisation (WHO) defines overweight and obesity as conditions of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired (World Health Organisation, 2000). In 2008, approximately 1.5 billion adults age 20 and above were found to be overweight with at least 500 million adults being obese while almost 43 million children below 5 years old were overweight in 2010 (World Health Organisation, 2011). While in Malaysia, 5.4% children below the age of 18 were overweight with a higher prevalence among males compared to females at 6.0 and 4.7% respectively (Ministry of Health Malaysia, 2008).

The fundamental cause of overweight and obesity is energy imbalance between the calories that one consumes and the actual calories used (World Health Organisation, 2011). This is often due to intake of energy dense food coupled with physical inactivity. In addition to that, underlying medical conditions (such as hypothyroidism and Cushing's syndrome) and consumption of certain medication (for example glucocorticoids and antiepileptic drugs) also contribute to increased body weight (Williams & Fryhbeck, 2009). Obesity has been associated with increased risk of metabolic and musculoskeletal disorders, malignancies, depression and anxiety. The healthcare system in Malaysia spent approximately RM489 million every year to combat obesity and its co-morbidities (Tan *et al.,* 2011)).

Previous studies have linked body mass index (BMI) and waist circumference (WC) to genetic factors (Maes *et al.,* 1997; Malis *et al.,* 2005; Moll *et al.,* 1991) as the human genes influence metabolic processes of the body (Clement, 2006). Since genetic factors have been revealed to be one of the possible causes of overweight and obesity, this study aims to provide information regarding the *FTO* gene among Malay children according to body weight and gender.

The *FTO* protein is a member of the non-heme dioxygenase (Fe(II)- and 2-oxoglutarate dependent dioxygenases) superfamily that takes part in various functions such as DNA repair and fatty acid metabolism but its exact function is still poorly understood (Gerken *et al.,* 2007). The rs9939609 variant had the highest genotyping success rate with 3 possible genotypes which are A/A, A/T and T/T (Frayling *et al.,* 2007). The *FTO* gene is a 417,978bp gene located on the long arm of chromosome 16.

The association between *FTO* gene and obesity has been well studied in the European population (Frayling *et al.,* 2007; Scuteri *et al.,* 2007; Cecil *et al.,* 2008). Obesity in Singaporean Malay adults was also associated with the common *FTO* variant (Tan *et al.,* 2008). It has been reported that individuals who are homozygous for the A allele are approximately 3 kilograms heavier and have 1.67-fold increased odds of being obese as compared to those with the T allele (Frayling *et al.,* 2007; Cecil *et al.,* 2008). However, the effect of rs9939609 weakens among men above 65 years old (Jacobsson *et al.,* 2011). Another study showed that the rs9939609 variant of *FTO* is only significantly associated with obesity among females and not among males (Jacobsson *et al.,* 2008).

METHODOLOGY

Subjects: The sample size was calculated using the G*Power software (Version 3.1.2, 2009) with type I error set at 0.05 while the power of the study was set at 0.80. Considering an estimated 15% drop out rate, the total sample size was 127 subjects. The subjects consist of volunteers from primary schools within the Kota Bharu district of Kelantan, Malaysia. Only healthy Malay children between 9 and 12 years old were included. Subjects of Malay parentage for less than three generations were excluded to avoid genetic diversity.

Ethics: Subjects and their parents/guardians were informed about the study design, procedures and possible risks of this study and written informed consent was obtained prior to the start of this study. This study has been approved by the Universiti Sains Malaysia Research Ethics Committee (Human).

Anthropometric measurements: Subjects' height and weight were measured using a wall-mounted stadiometer (Seca Bodymeter 208, Germany) and a weighing scale (Tanita THD-306, Japan) respectively. The BMI was determined using the standard formula. A non-stretchable measuring tape was placed at the midway between the lower costal margin and iliac crest (Callaway *et al.,* 1988) to measure the waist circumference. The body fat percentage was measured using an Omron body fat monitor (Omron HBF-302, Japan). The cut-off values for determination of overweight based on BMI, waist circumference and body fat percentage was based on Cole *et al*. (2000), Liu *et al*. (2010) and Lee *et al*. (2007) respectively.

Rs9939609 polymorphism analysis: Genomic DNA was extracted from 2ml of whole blood using standard protocols from the manufacturer (GeneAll Exgene Blood SV mini kit, Korea). DNA amplification using standard PCR method was performed with forward and reverse primers based on Tanofsky-Kraff et *al.* (2009). The Varian Helix Denaturing High Performance Liquid Chromatography (DHPLC) system (Varian, USA) was used to screen the *FTO* rs9939609 polymorphism at 55.5°C. Sequencing reactions performed using Applied Biosystems BigDye terminator chemistry and run on ABI 3730XL capillary-based DNA sequencer was used to confirm any peculiar peak in the DHPLC results.

Statistical analysis: All statistical analyses were performed using Statistical Package for Social Science (SPSS version 18). : In-Silico Online Fisher's exact test calculator was used to analyse data distribution the associated independent variables (Joosse, 2011). A ρ-value of <0.05 was considered statistically significant.

RESULTS

107 subjects completed this study with 27 dropouts. The subjects consisted of 42 (39.3%) males and 65 (60.7%) females. Characteristics of the subjects are shown in Table 1 based on BMI category.

Table 1: Subject characteristics according to BMI category. Data is presented as mean ± standard deviation.

	Overweight (n = 51)	Normal (n = 56)
Age (years)	10.7 ± 0.9	10.6 ± 0.9
Height (cm)	142.5 ± 0.1	137.9 ± 0.1
Weight (kg)	52.7 ± 10.4	31.5 ± 7.2
BMI	25.7 ± 3.4	16.4 ± 2.3
Waist circumference (cm)	80.0 ± 8.8	56.9 ± 5.8
Percent of body fat (%)	33.4 ± 2.9	19.3 ± 7.1

Blood samples from all subjects successfully underwent DNA extraction, PCR and DHPLC with an average concentration of extracted DNA of 13.0 ± 8.84 ng/µl. Based on the sequencing results, the rs9939609 polymorphism of the *FTO* gene was present in the Malay population with the minor A allele frequency at 0.25. Figure 1 shows examples of the gel electrophoresis results for genomic DNA and PCR products. Samples of DHPLC and sequencing results are presented in Figure 2.

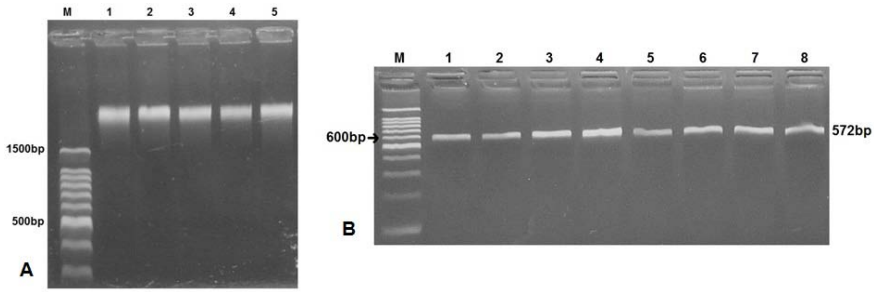

Figure 1: A - Gel electrophoresis of genomic DNA (Lane M – 100bp DNA marker (Promega, USA), Lane 1 to 5 – subjects' DNA). B - Gel electrophoresis of PCR products. (Lane M – 100bp DNA marker (Promega, USA), Lane 1 to 8 – subjects' PCR products).

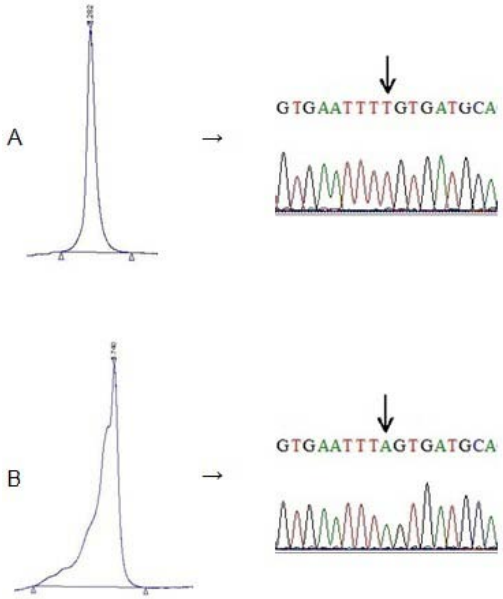

Figure 2: Figures on the left show the DHPLC results while the figures on the right show the sequencing results for A – negative control (normal) and B – positive control (homozygous mutation).

Based on the results from the Fisher's exact test, there was no association between *FTO* rs9939609 polymorphism and BMI categories (ρ=0.9014), waist circumference categories (ρ=0.6828) and body fat percentage categories (ρ=0.9011) as shown in Tables 2, 3 and 4.

Based on the Fisher's exact test result, there was no association between gender and rs9939609 polymorphism (ρ=0.3345).

Table 2: Association between FTO rs9939609 polymorphism and BMI categories (n = 107).

BMI category	*FTO* rs9939609 polymorphism			ρ-value
	TT	AT	AA	
Normal	32	21	3	0.9014
Overweight	27	21	3	

Table 3: Association between FTO rs9939609 polymorphism and waist circumference categories (n = 107).

Waist circumference category	*FTO* rs9939609 polymorphism			ρ-value
	TT	AT	AA	
Normal	43	28	5	0.6828
Overweight	16	14	1	

Table 4: Association between FTO rs9939609 polymorphism and percentage of body fat categories (n = 104).

Percentage of body fat category	*FTO* rs9939609 polymorphism			ρ-value
	TT	AT	AA	
Normal	23	17	3	0.9491
Overweight	34	24	3	

Table 5: Association between FTO rs9939609 polymorphism and gender (n = 107).

Gender	*FTO* rs9939609 polymorphism			ρ-value
	TT	AT	AA	
Female	33	29	3	0.3345
Male	26	13	3	

DISCUSSION

Although genetics have been known to strongly influence the human body weight (Malis *et al.,* 2005; Moll *et al.,* 1991; Silventoinen, 2010), the relationship between specific polymorphisms and obesity remains largely unknown. This study attempted to investigate the association between the common rs9939609 variant of the *FTO* gene and overweight among Malay children.

27 subjects (20.1%) have dropped out mainly due to unsuccessful venipunctures and this resulted in a relatively modest sample size. Similar early researches on non European populations with smaller sample sizes have yielded insignificant associations (Scuteri *et al.,* 2007; Li *et al.,* 2008; Horikoshi *et al.,* 2007; Ohashi *et al.,* 2007). This could probably be explained by the lower minor allele frequency (MAF) in these ethnicities as shown by a meta analysis in 2011 that reported that the MAFs in Caucasian and Hispanic populations (more than 0.31) are two times higher compared to the Asians and South Americans (between 0.11 and 0.2) as the *FTO* gene is considered a low-penetrance susceptible gene

(Peng *et al.,* 2011). Recent studies with large sample sizes have published significant associations between *FTO* gene polymorphism and obesity (Peng *et al.,* 2011; Hassanein *et al.,* 2010; Huang *et al.,* 2011; Okuda *et al.,* 2011; Li *et al.,* 2012). On the contrary, the *FTO* gene has been consistently associated with the human body weight in European adults and children (Frayling *et al.,* 2007; Scuteri *et al.,* 2007, Hinney *et al.,* 2007).

Besides that, the other reason that can explain this outcome is the genetic diversity among different ethnicities. As an example, the *FTO* gene have been associated with obesity in African-derived populations (Hassanein *et al.,* 2010). However, the strongest association was via two different SNPs (rs3751812 and rs9941349) as compared to the primary associating SNP in Europeans (rs9939609). Therefore, it is possible that a different SNP in the *FTO* gene might have greater association with overweight and obesity in the Malay population.

The relationship between the *FTO* gene and gender have not been showing consistent associations as shown by previous studies (Frayling *et al.,* 2007, Jacobsson *et al.,* 2008; Rankinen *et al.,* 2010; Xi *et al.,*2010; Karns *et al.,* 2012). Jacobsson et al. (2008) stated that the association between the rs9939609 variant and adiposity only exist among females. On the other hand, Rankinen et al. (2010) and Xi et al (2010) reported that the association between *FTO* gene and fat mass was evident only in males and not females. This study together with several other studies (Frayling et al., 2007; Karns et al., 2012) revealed no association between the *FTO* gene and gender. Thus, further studies are warranted to determine the exact relationship between gender and *FTO* gene.

Even though this study did not find any significant association between the rs9939609 polymorphism and overweight in Malay children, a study on Malay adults (Tan *et al.*, 2008) reported otherwise. For this reason, it is recommended to follow up on subjects with homozygous or heterozygous T>A rs9939609 polymorphisms to find out possible trends in the following years. This study was limited by the relatively modest sample size (due to dropouts) and absence of specific cut-off values for waist circumference, and body fat percentage for the Malay population. As such, the findings are only valid for the Malay population.

CONCLUSION

This study found no significant association between the rs9939609 polymorphism of the *FTO* gene and overweight measures and gender. Further monitoring of subjects with homozygous or heterozygous mutations are suggested as well as to repeat the study with larger sample size and to establish cut-off values for overweight determination in Malay children. DHPLC can be recommended for use as a screening method for determination of the *FTO* rs9939609 polymorphism.

ACKNOWLEDGEMENTS

The authors would like to thank the helpers during the data collection (C. W. Salma binti C. W. Zalati, Juliana binti Johan John, Nur Atiqah Wadiah Azmi and Siti Sabrina Johari), staffs of the Sports Science Unit and Human Genome Centre, the subjects of this study and staffs of participating schools. This study was funded by the Universiti Sains Malaysia Short Term Grant (304/PPSP/61312029).

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Effects of Cessation of Jumping Exercise and Honey Supplementation on Tibia Bone Properties in Young Female Rats

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Abstract

Exercise has been shown to be beneficial to the skeleton, but whether exercise-induced positive effect on bone can be maintained after cessation of exercise is controversial. Eighty four 12 week-old Sprague-Dawley female rats were divided into 7 groups (n=12 rats per group): 16S (16:16 weeks; S:Sedentary without honey supplementation), 16J (J:Jumping), 16H (H:Honey), 16JH (JH:Combined jumping and honey), 8J8S (8:8 weeks), 8H8S, and 8JH8S. Jumping exercise consisted of 40 jump/day for 5 days/week at a height of 40 cm. Honey was given to the rats at a dosage of 1 g/kg body weight/rat/day via force feeding for 7 days/week. Jumping exercise, honey supplementation or both jumping exercise and honey supplementation were terminated for 8 weeks in 8J8S, 8H8S and 8JH8S groups. At the end of the experimental period, the rats were sacrificed and left hind leg tibiae were harvested in order to measure tibial proximal total bone density (tBD) and tibial cortical area. Statistical analysis was performed using one-way ANOVA. Sixteen weeks of jumping exercise and honey supplementation resulted greater tibial proximal total bone density and tibial cortical area in 16JH as compared to 16S. After 8 weeks of cessation, statistically significant higher values were observed in these two parameters in 8JH8S as compared to 16S. The results of the present study showed that 16 weeks of jumping exercise and honey supplementation elicited beneficial effects on tibial proximal total bone density and tibial cortical area. The improvements in these measured bone parameters resulted from 8 weeks of combined jumping exercise and honey supplementation still could be seen even after 8 weeks of cessation of jumping exercise and honey supplementation.

INTRODUCTION

Since osteoporosis has become one of the major public health problems in men as well as women and the cost of treatments rises every year, strategies to prevent this disease and lower the risk of related fractures are very considerable. Early physical activities along with adequate nutritional intake have been prescribed for maximizing bone mass and minimizing bone loss in later life (Anderson & Metz, 1993). Throughout the growth years, skeleton is most responsive to exercise. Therefore, physical activity during adolescence and young ages could be one of the most significant determinations of peak bone mass (Slemenda *et al.,* 1991; Teegarden *et al*., 1996; Courteix *et al*., 1998). As reported by numerous studies, the mechanical loading applied by exercise results in increases in bone mass and strength (Holy and Zerath, 2000; Turner and Robling, 2005). Welch *et al.* (2007) reported that impact exercise of 10 times free fall per day, is beneficial to growing bones in rats. In animal studies, Renno *et al.* (2006) reported that progressive load exercise program consisted of 4 bouts of 10 jumps with additional load on animal's body, had a stimulatory effect on bone and muscle tissues in the osteopenia rats. In human studies, Bassey and Ramsdale (1994) found that healthy premenopausal women had greater femur bone density after 6 months of intermittent high-impact exercise compared to controls. Bailey and Brooke-Wavell (2010) reported that high-impact exercise performed daily for 6 months increased bone mineral density (BMD) at the femoral neck of healthy premenopausal women.

Besides physical activity, nutrition is another lifestyle factor that influence bone health (Murphy and Carroll, 2003). The positive effects of different nutritional supplements such as soy or soy isoflavones, calcium and vitamin D supplementation on bone have been reported (Arjmandi *et al.*, 1996, Arjmandi *et al*., 1998; Arjmandi, *et al*. 2002), and when it was combined with physical activity (Choi, 2004; Figard *et al.,* 2006). Honey which has been used as a food preserving agent for a long time is also well known for its beneficial actions in treatment of various medical diseases (Klein *et al*., 2000; Al-Waili 2003; Al-Waili *et al*. 2006). It also has been reported that honey can increase calcium absorption after acute feeding in growing rats (Ariefdjohan *et al*., 2006).

Although the effects of increased mechanical loading on skeleton are obvious, the skeleton's ability to preserve the exercise induced bone gain after the cessation of exercise is not clear (Seeman, 2000). Some animal studies reported the preservation of exercise benefits (Silbermann *et al.,* 1991; Kuichi *et al*., 1998; Singh *et al*., 2002; Ooi *et al*., 2009), whereas others have shown the loss of the exercise-induced bone gain after the exercise ceased (Iwamoto *et al*., 2000; Yeh *et al*., 1990). It is known that during childhood or adolescence, exercise results in increase in bone mass together with bone morphological changes (MacKelvie *et al*., 2002). However, it is still unclear whether the combined effects of exercise and nutritional supplementation on bone health during young age can be preserved after a certain period. Since the effects of combined exercise and honey supplementation and its cessation on bone properties has not been investigated, thus the present study was proposed to evaluate the effects of cessation of jumping exercise and honey supplementation on tibia bone properties in young female rats.

MATERIALS AND METHOD

Animals

Eighty four eleven-week old Sprague-Dawley female rats were obtained from Laboratory Animal Research Unit, Universiti Sains Malaysia, and were placed in the experimental room. After one week of acclimatization to the environment, the rats were weighed for their initial body weight. Then the rats were block-randomised into seven initial body-mass-matched groups with 12 rats per group (6 rats per cage). Temperature and humidity of the room were maintained throughout the study under constant temperature of 24ºC and relative humidity of 70-75%. The rats were exposed to a constant 12:12 light/dark cycle, with the light period starting from 7.00 p.m to 7.00 a.m for the entire experimental period. The reversed light/dark cycle was implemented to allow jump training during the day. At the end of the experimental period, the rats were weighed once again in order to obtain the final body weight. They were then anaesthetised, one at the time, by being placed for 2-3 minutes in a desiccated jar containing a chloroform soaked gauzed pad, before being decapitated using a small guillotine (Scientific Research Instrument, U.K.). The left hind leg was dissected for the measurement of bone properties. The research protocol was approved by animal research committee of Universiti Sains Malaysia, No.: USM/Animal Ethics Approval/2008/(39)(121).

Experimental design

In this study, the rats with initial body mass ranged 190-220 grams were randomly assigned to seven groups, with twelve rats in each (n=12): 16 weeks of sedentary without supplementation (16S), 16 weeks of jumping exercise (16J), 16 weeks of honey supplementation group (16H), 16 weeks of combined jumping exercise and honey supplementation group (16JH), 8 weeks of jumping exercise followed by 8 weeks of sedentary group (8J8S), 8 weeks of honey supplementation followed by 8 weeks of non supplementation group (8H8S), 8 weeks of combined jumping exercise and honey supplementation followed by 8 weeks of sedentary and non supplementation group (8JH8S). All the rats were sacrificed at the age of twenty eight week-old.

Training programme

Rats in the exercise groups were trained to jump using a previously described protocol (Umemura *et al*., 1995; Umemura *et al*., 1997; Ooi *et al*., 2009). Each rat was placed in a specially designed wooden box, measuring 30.5 x 30.5 x 40 cm in length, width and height respectively, and with a copper strip base that formed an electrical grid. The jumping exercise was initiated by applying electrical stimulation to the base of the box through a stimulator (Grass S48, U.S.A.). The stimulator was set to automatically deliver a stimulus of 50-80 V for 1 second and at 3 second intervals. To begin the exercise session, the rats were placed on the electrical grip with the stimulator turned off. When the stimulator was turned on, the rats jumped from the floor of the box to catch the top edge of the box with their forepaws. Upon reaching the top, they were then immediately repositioned by hand to the floor of the box to repeat the procedure. Jumping exercises were carried out from 8:30 a.m. to 11:30 a.m. Each rat was subjected to the exercise for 5 minutes duration per day for 5 days per week. The requirement for electrical stimulus decreased over time when the rats became accustomed to the jumping exercise.

The jump training began with an initial jumping height of 20 cm, after which the height was increased gradually to 40 cm by the third day. The rats that refused to jump were stimulated by the low voltage of electrical stimulation. The sedentary rats in the control group (free cages activity) were not given any electrical stimulus. In order to mimic the stress induced by handing before and after jumping exercise, the sedentary rats were handled 5 days per week for 16 weeks.

Honey supplementation

Rats in honey group and combined jumping and honey group were received honey as oral supplementation at the dosage of 1 g / kg body mass / rat / day via force feeding (gavages), 30 min prior to the jumping exercise (Tavafzadeh *et al*., 2011). Body mass of the rats was measured biweekly, and the dosage of honey was calculated based on the most recent body mass.

Cessation of jumping exercise and honey supplementation

Jumping exercise was terminated after 8 weeks in 8J8S and 8JH8S groups, and the rats underwent a cessation phase for another 8 weeks. At the same time, no honey supplementation was given to the rats in 8H8S and 8JH8S groups after 8 weeks, and the rats in these groups experienced their sedentary life without honey supplementation for another 8 weeks. During the cessation phase, rats maintained their normal cage activity and handling was performed for the rats 5 days per week. Rats in 16J, 16H and 16JH groups had their exercise, or supplementation, or combined exercise and supplementation regimen respectively for a total of 16 weeks.

Bone harvesting and measurements

Immediately after sacrificing, the left hind tibiae of the rats were dissected. After removal of the flesh from the tibiae, they were then soaked in saline to prevent dehydration. The tibiae were then put into labelled plastic bags and stored at -80ºC (Heto Ultra Freezer 3410, Denmark) for the subsequent measurement, of bone mineral density and cortical area.

Micro-CT analysis of bone mineral density and cortical area

The night before the measurement of bone mineral density, bones were thawed by keeping them at 4ºC. On the day of bone densitometry measurement, the bones were placed in a custom-made plastic container designed for rats' tibiae. The proximal regions of the bones were then scanned using micro-computed tomography (micro-CT) scanner (XtremeCT, Scano Medical, Bruttisellen, Switzerland) with the resolution of 40µm, and a total of 100 slides were selected to contour and then calculated using the built-in XtremeCT software programme for measuring densitometry parameters including tibial proximal total bone density, and tibial cortical area (Xie, *et al*., 2012).

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) version 19.0 was used for the statistical analysis. All the data are presented as mean ± standard deviation (SD). One way analysis of variance (ANOVA) was performed to determine the significant differences between groups.

When the one way ANOVA revealed a significant difference, *post hoc* (least significant differences test) was used to determine the differences between specific means. *´P´* of <0.05 was considered as statistically significant and used for all the comparisons.

RESULTS

Initial body weight of the rats did not significantly differ among the groups. Likewise, after sixteen weeks of experiment, no changes in body weight of the rats were observed (Table 1).

Table 1: Initial and final body weight of the rats (Mean ± SD)

Groups	Initial body weight (g)	Final body weight (g)
16S	200.3 ± 7.6	248.1 ± 15.7
16J	202.9 ± 14.1	259.9 ± 28.3
16H	200.1 ± 12.6	246.1 ± 22.3
16JH	203.9 ± 12.9	252.0 ± 24.0
8J8S	203.3 ± 10.0	246.6 ± 15.0
8H8S	203.2 ± 11.6	251.5 ± 14.5
8JH8S	202.1 ± 10.7	247.7 ± 9.5

Tibial proximal total bone mineral density

As presented in Figure 1, mean proximal total bone mineral density was significantly higher in tibiae of the rats in 16JH group as compared to 16S group ($p<0.05$). Similarly, mean proximal total bone mineral density was observed to be significantly higher in 8JH8S as compared to control group ($p<0.05$). There were no significant differences in 8JH8S as compared to 16JH in this measured parameter. However, mean proximal total bone mineral density was significantly higher in 8JH8S than 8H8S ($p<0.01$). The present study also found that 16J and 16H showed no differences with 16S.

Tibial proximal cortical area

Results of tibial proximal cortical area are illustrated in Table 2. In the present study, tibial cortical area was significantly higher in 16JH as compared to control group ($p<0.05$). Similarly, 16J also showed greater value as compared to 16S ($p<0.05$) in this parameter. After cessation phase, tibial cortical area was significantly higher in 8JH8S as compared to control ($p<0.05$) and 8H8S ($p<0.05$). There was significant lower value of tibial cortical area in 8J8S as compared 16J ($p<0.05$). 8H8S also showed significant lower value when compared with 16H ($p<0.05$).

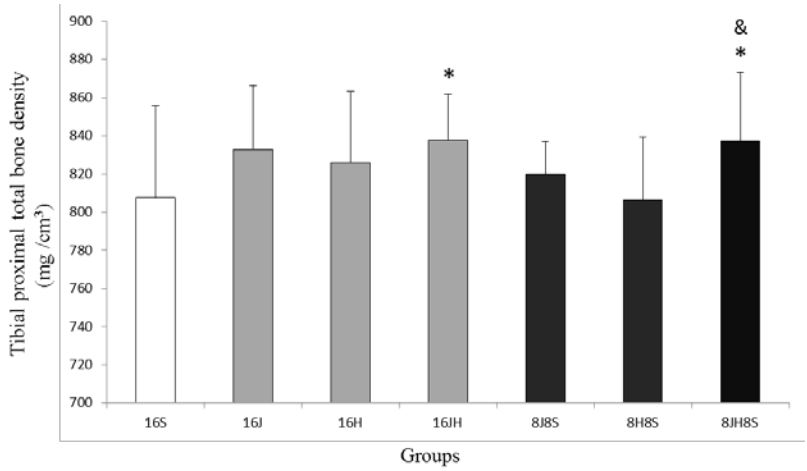

Figure 1: Mean proximal total bone density of the tibiae of the rats (Means ± SD)
*, p<0.01 as compared to 16S
&, p<0.01 as compared to 8H8S

Table 2: Cortical area of the tibiae of the rats (Mean ± SD)

Groups	Tibial cortical area (mm^2)
16S	8.1 ± 0.9
16J	9.1 ± 0.9*
16H	8.2 ± 1.2
16JH	9.1 ± 0.8*
8J8S	8.2 ± 0.6#
8H8S	7.9 ± 1.3+
8JH8S	8.9 ± 1.2*, &

*, p<0.05 as compared to 16S
&, p<0.05 as compared to 8H8S
+, p<0.05 as compared to 16H
#, p<0.05 as compared to 16J

DISCUSSION

The main findings of the present study are there were overall improvements in tibial total bone mineral density and cortical area after 16 weeks of jumping exercise and honey supplementation. Additionally, after 8 weeks of sedentary without supplementation, tibial proximal total bone density and tibial cortical area were significantly higher in 8JH8S as compared to 16S which may imply that the beneficial effects of 8 weeks of jumping exercise and honey supplementation still can be remained even after the 8 weeks of cessation.

In the present study, 16 weeks of jumping exercise combined with honey supplementation increased tibial proximal total bone density (tBD) and tibial cortical area as compared to sedentary control group. However, 16 weeks of jumping exercise alone only showed improvement in tibial cortical area. These findings imply that more beneficial bone effects can be observed when jumping exercise combined with honey supplementation than jumping exercise alone. High impact exercise is considered to be one of the effective exercises on osteogenic response, because its intermittent dynamic loading is known to be more effective in increasing bone health than static loading (Umemura *et al*., 2002). Moreover, the dynamic loading in high-impact exercise can produce a high magnitude strain and strain rate on bones, which are important factors for osteogenic response (Honda *et al*., 2003). Jumping exercise, which is a high impact weight bearing exercise, produces large ground reaction force accompanied with muscular contraction force on bone is consider more effective as compared to low impact or non-weight bearing exercises to increase bone mass and strength (Fuchs *et al*., 2001).

The positive effects of exercise on bone as observed in the present study have been reported by several related previous studies. Umemura *et al*. (2002) reported that 3 weeks of daily jumping exercise increased femoral cortical area and total bone mineral density in 4-week old mice. Honda *et al*., (2003) also reported that in jump-exercised rats, significantly increased tibial bone mass, strength, and cortical areas were observed. In another study by Umemura *et al*. (2008a) it was shown that three sessions per week of ten jumps per session resulted in significantly greater tibia fat free dry weight, strength and mid-shaft cortical area. In general, the finding of the present study along with the previous mentioned studies indicate that the responses to mechanical loading induced by jumping exercise resulted in increases in bone properties in rats.

It was hypothesized by the authors that combination of physical activity and supplementation may play a vital role in enhancing and maintenance of bone gain. The present finding of increases in total proximal bone density and cortical area with 16 weeks of combined jumping exercise and honey supplementation has confirmed our hypothesis. In our recent previous study, it was found that a shorter duration, i. e. 8 weeks combination of jumping exercise and honey supplementation elicited more discernable beneficial effects on tibia and femur bones generally when compared to either jumping exercise or honey supplementation alone in young female rats (Tavafzadeh *et al*., 2011).

Honey has been reported to increase intestinal calcium absorption due to its carbohydrate nature (Ariefdjohan *et al*., 2008). It is speculated that honey supplementation during jumping exercise in the rats may have increased the intestinal calcium absorption and subsequently enhancing bone mineral density and cortical area of the rats. The evidence of effect of exercise is enhanced in the presence of adequate calcium intake has been reported

by Welch & Weaver, (2005) that a combination of moderate-impact exercise and adequate calcium intake can increase bone strength during childhood. Specker and Binkley (2003) also reported that among children receiving calcium, bone thickness and area of the leg were larger when combined with physical activity.

In the present study, 8 weeks of jumping exercise and honey supplementation followed by 8 weeks of sedentary without supplementation (8JH8S) exhibited significantly greater tibial proximal total bone density and tibial cortical area as compared to control group (16S), implying that the beneficial effects of jumping exercise and honey supplementation in proximal total bone density and cortical area may still be remained after 8 weeks of cessation. Our study results also showed that, 8 weeks of jumping exercise alone did not result in any improvement after the 8 weeks of cessation.

Controversial findings were reported with regards to preservation of exercise-induced bone gain after the exercise ceased. Umemura *et al*. (2008b) reported that the effects of jump training on tibial bone strength, mass, and width of the tibial diaphysis were preserved after 24 weeks of detraining. Similarly, Singh *et al*. (2002) indicated that high impact jump exercise per session, performed 5 days per week for 4 weeks, leads to an increased cortical bone with enhanced periosteal bone formation, which is also maintained after cessation of exercise. The authors suggested that high impact jump exercise may provide greater safety margin against disuse-related or/and age-related bone loss and skeletal fragility later in life.

On the other hand, a study done by Yeh & Aloia, (1990) on young female rats, they found that a 4-week period of deconditioning was sufficient to vanish the beneficial effects of 8 weeks of exercise on bone mineral content, bone mineral density and dynamic parameters of bone formation and resorption. Similarly, Iwamoto *et al*. (2000) reported that after deconditioning, exercised rats lost the beneficial gained through 8 weeks of exercise and their bone parameters were reduced to levels not different from the sedentary control. Differences in these studies could be due to differences in age, strain of the animals, or the experimental environment, e.g. food given, room temperature, humidity and particularly the nature of the exercise regimen.

In the present study, the beneficial effects of jumping exercise preserved after the cessation, only when the exercise combined with honey as the supplementation. The absorption of calcium contained in honey into the blood during exercise and subsequently enhancing bone properties may have played a role in eliciting the positive effects of the combination of exercise and honey as observed in the present study. Honey is a commonly used sweetener consisting of the carbohydrates of fructose, glucose and raffinose. Various studies on animal model have observed the calcium uptake-enhancing effects of raffinose (Mineo *et al* 2001; Mitamura *et al*., 2004) which is also present in honey.

The mechanism in which honey and other nondigestable carbohydrates can increase calcium absorption as mentioned in Ariefdjohan *et al*. (2008) and Scholz-Ahrens *et al*. (2001) could be that in the gastrointestinal (GI) tract, nondigestable carbohydrates resist hydrolysis by digestive enzymes, so that carbohydrates pass through the small intestine, and eventually reach the cecum and colon. At these sites, they are fermented by the residing bacteria to produce byproducts such as short-chain fatty acids, resulting in a decrease in intestinal pH, which leads to an increase in mineral solubility such as calcium. Ariefdjohan *et al*. (2008) also reported that, rats fed with 800 mg of honey had significantly higher percent calcium absorption than those fed with glucose-fructose mixture or a low dose of

raffinose. This suggests that there may be other factors such as flavonoids, vitamin D and vitamin K in honey that contribute to its calcium absorption enhancing effect.

However, honey supplementation alone did not significantly improved bone properties in the present study. The lack of long-term nutritional benefit may be attributed to several factors. One of the factors could be that honey containes calcium, and as reported by Brommage *et al*. (1993), upon prolonged administration of a highly bioavailable calcium load, colonic calcium absorption adapts to maintain homeostasis. The parathyroid hormone-vitamin D mechanism may be suppressed by the initial increase in calcium absorption. Subsequently, this event down-regulates the active transport of calcium absorption.

In conclusion, the present study found that 16 weeks of jumping exercise and honey supplementation elicited more beneficial effects on tibia bone in comparison with jumping exercise or honey supplementation alone. Additionally, the beneficial effects of 8 weeks of jumping exercise and honey supplementation on tibia bone properties still could be remained even after 8 weeks of cessation of exercise and supplementation. Therefore, the results obtained from the present study can be used as a foundation for studies involving human subjects, while determining the effectiveness of combined jumping exercises and honey supplementation as guidelines for enhancement of bone health in humans.

ACKNOWLEDGMENTS

This work was supported by a 'Research University' grant from the Universiti Sains Malaysia, Malaysia (Grant number: 1001/PPSP/811079). Special thank to Prof. Qin Ling, Prof. Hung and the staff of Musculoskeletal Research Laboratory, Department of Orthopaedic and Traumatology, The Chinese University of Hong Kong, Hong Kong for the technical support.

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Determination of Malaysian Athletes' Attitude Towards Seeking Sport Psychology Services

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Abstract

Despite the increased attention given to sport psychology and its benefits to sport performance, some athletes and coaches remain hesitant to use sport psychology services. There are many possible reasons for athletes not taking advantage of sport psychology services. This study was conducted to determine the attitudes of Malaysian junior athletes towards seeking sport psychology services. The influence of athletes' demographic characteristic such as gender on attitudes was explored. Malaysian junior athletes (N = 122; male = 72 and female = 50) who are currently participating or had participated in the state and junior sport events participated in this study. Participants completed a set of questionnaire that consisted of 2 parts; (a) Demographic and (b) Sport Psychology-Revised (SPA-R) questionnaire. SPA-R was used as a measure of attitudes within Theory of Planned Behavior (Ajzen & Fishbein, 1980). Athletes in this study reported a generally positive attitude towards sport psychology services, and were not likely to be resistant to sport psychology services. They reported high levels of confidence in sport psychology, which indicated that they believed that sport psychology consultation and mental training might be useful and beneficial. Gender did not significantly influence athletes' attitude towards seeking sport psychology assistance. The results also suggested that the athletes' in the present study believed that psychological interventions have more potential gains than losses as evidenced by high score in Confidence in Sport Psychology subscale. Practitioners need a greater understanding of athletes' attitudes towards sport psychology so they can improve their services to best meet the needs of athletes.

INTRODUCTION

There are moments in sport performance when psychological strength differentiates between successful and less successful athletes. To improve the psychological aspects of sport performance, psychological skills training has been recognized as an effective method. Despite the growth of psychological training in recent years and its benefits to sport performance, some athletes and coaches remain hesitant to use sport psychology

services (Martin, 1998). In some cases, there are athletes who choose not to consult sport psychologist or seek psychology services although they do recognize and know the potential benefits of sport psychology (Leffingwell *et al*., 2001). In order for psychological techniques to be effective, athletes must participate in the program actively and voluntary from the beginning (Schellenberger, 1990). Resistance in following advices from sport psychology consultation will inherently influence psychological intervention effectiveness.

There are many possible reasons for athletes not taking advantage of sport psychology services. Harmison (2000) research offer several explanations about the reasons of athletes' hesitancy to use sport psychology, including wrong perception and skepticism about the field of sport psychology, fears of being stigmatized, and a lack of openness and willingness to make mental training a priority. Some of the sport practitioners did not give much credibility to sport psychology consultants (Ravizza, 1988). Meanwhile, some athletes are unaware of potential benefits that they may obtain from sport psychology (Leffingwell *et al*., 2001).

In attempts to gain more information regarding athletes' attitude towards seeking sport psychology services, a number of study have been conducted. For instance, Anderson, Hodge, Lavallee and Martin (2004) have extended previous work investigating the issue of athletes' attitude towards seeking sport psychology. The finding of this research provides information about attitude of New Zealand athletes and suggests that they have positive attitude towards using sport psychology. Result from this research revealed that New Zealand athletes are not likely to be resistant to practitioners offering sport psychology services. In this study, they are confident in sport psychology, generally open to psychological consultation and identify with their culture. This suggests that New Zealand athletes have preference for working with a consultant from the same background. Gender, previous experience, type of sport involved and level of performance are the influential factor of athletes' attitude. However, male athletes and those who have no experience with psychological skill training may have less positive attitude. The measurement instrument used in this study is Sport Psychology Attitude-Revised Questionnaire (SPA-R). Subjective norm (perceived social pressure) and perceived behavioral control (person's belief in their ability and control to execute a behavior) were also influential on intention to use sport psychology. This findings support the Theory of Planned Behavior.

Contrary to Anderson *et al*. (2004), athletes from the United States, United Kingdom and Germany showed slightly different attitudes towards sport psychological consultation. Martin, Lavallee, Kellmann, and Page (2004) explored attitudes about sport psychology consulting of athletes living in United States, United Kingdom, and Germany. The measurement instrument used in this study is Sport Psychology Attitude-Revised Questionnaire (SPA-R). Athletes from United States were more likely to have stigma towards seeking assistance from sport psychology practitioners than were athletes from United Kingdom and Germany. Meanwhile, United Kingdom athletes were more confident in the abilities of psychological training program and less likely to identify their culture and ethnicity compare to athletes from other countries. Attitudinal differences between various cultural and social groups may be a result of different ideologies and social philosophies (Cohen, Guttmann & Lazar, 1998). This investigation also reported that personal characteristics of an athlete such as gender, previous experience and type of sport involved can influence athletes' attitude towards sport psychology services. Athletes competing in physical-contact sports had more negative view and perception of sport psychology consulting compared to athletes from physical non-contact sport. Findings of this research

also show that athletes with previous consulting experience had greater appreciation of mental skills training and were more likely to seek psychological assistance in the future than those who had no consulting experience. Martin *et al*. (2004) also stated that female athletes have more positive attitude towards psychological help and were more open to seek assistance compare to male athletes.

Lavallee, Jennings, Anderson and Martin (2005) administered Sport Psychology Attitudes-Revised (SPA-R) questionnaires to Irish elite athletes that assessed their attitude and view towards sport psychology assistance. The results revealed that Irish athletes generally have positive attitude towards sport psychology services. They reported moderately high levels of confidence in sport psychology and were also identified as being open to receiving sport psychology consultation. The openness of the athletes exists regardless of the cultural background of the sport psychologist as evidenced by lower score on the Cultural Preference subscale. Comparison of results with athletes from other countries (United States, United Kingdom, Germany and New Zealand) revealed that Irish athletes held a generally positive attitude. Irish athletes scored highest on the Stigma Tolerance subscale comparatively, suggesting that this positive attitude may be based on factors not directly associated with personal experience of sport psychology (Lavallee *et al*., 2005).

Table 1: Comparison of Malaysian athletes' attitude with athletes of other countries

	Ireland ***(N=240)***		**New Zealand** ***(N=112)***		**United Kingdom** ***(N=147)***		**United States** ***(N=404)***		**Germany** ***(N=260)***	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Stigma Tolerance	3.94	0.65	2.00	0.80	2.49	0.81	2.76	0.99	2.49	0.91
Personal Openness	3.51	0.73	3.70	1.10	4.33	0.90	4.43	0.93	4.22	0.90
Cultural Preference	3.05	0.82	3.92	1.00	2.67	1.16	3.47	1.29	3.08	1.25
Confidence in Sport Psychology	4.24	0.59	5.23	0.90	4.69	0.90	4.63	0.99	4.38	0.99

It is important to understand athletes' and coaches' acceptance (attitude and preference) of sport psychology services because it will give impact on intervention effectiveness. In order to increase the number of athletes seeking out sport psychology services voluntarily and adhere to psychological training program; their attitude, motivation, beliefs and behavior towards the program must be addressed (Bull, 1991). It is important because their views will have implications for acceptability, adoption, and service use (Brewer *et al*., 1994). Absence of positive attitude towards mental skill training may influence athletes' intention to practice sport psychology skill voluntarily.

Conceptual Framework

Theory of Planned Behavior is a conceptual framework that has been used to explain how knowledge and perception will affect ones attitude, and its relationship with behavioral intention. There are several studies that used Sport Psychology Attitude-Revised (SPA-R) questionnaire as a measure of attitude within the Theory of Planned Behavior to predict athletes' intentions to use sport psychology services (Anderson *et al*., 2004; Martin *et al*., 2002). Theory of Planned Behavior deals with the antecedents of attitude, subjective norms, and perceived behavioral control to determine intentions and actions. The general rule of this theory is the more favorable attitude and subjective norm, and the greater the perceived control, the stronger should be the person's intention to perform the behavior in question. Measuring athletes' attitudes can provide useful information regarding their intentions to use sport psychology services.

Problem Statement

Not much is known regarding awareness of sport psychology services among Malaysian athletes. Anecdotal evidence suggests that sport psychology is not considered a priority of training program. Indeed, there is little information regarding Malaysian athletes' attitude towards seeking sport psychology services. This is an under-develop issue in Malaysia. It is important to assess athletes' acceptance and view towards sport psychology services because it contributes to athletes' intention to practice sport psychology skills. Athletes' attitudes not only affect their intentions to practice sport psychology skill but also influence their adherence to mental skill training (Harmison, 2000). Besides investigating athletes' attitude towards psychological skill training program, it is also necessary to explore the factors that may influence athletes' attitude. Gender, age, competitive level, previous experience and type of sport involved may influence their willingness to seek sport psychology services. Thus, the objective of this study was to determine the attitudes of Malaysian Junior Elite athletes towards sport psychology services

METHODS

Participants

Malaysian athletes (N = 122, male = 72 and female = 50) who are currently participating or had participated in the state and junior sport events were recruited. The participants ranged in age from 13 to 24 years (M = 16.51, SD = 2.11). The participants are comprise of state athletes (n = 64) and junior level athletes (n = 58) from three countries in Malaysia, Johor, Kelantan and Terengganu.

Measurement Instrument

Measurement instruments used in this study were (1) Demographics, and (2) Sport Psychology Attitude-Revised (SPA-R) questionnaire. Details description of each of these questionnaires was presented below.

Demographics

A demographic information form was used to assess participants' personal information such as age, gender, race, education level and completed years of sports participation. Each

participant also was asked to indicate their previous experience with sport psychology consultant before (a) on a personal problem or issue and (b) on a performance- related problem or issue. Each participant who previously had worked with a sport psychology consultant also was asked to rate on 3-point Likert scales the helpfulness of the sport psychology services and their satisfaction with their experience.

Sport Psychology Attitude-Revised questionnaire (SPA-R; Martin *et al*., 2002)

The Sport Psychology Attitude-Revised questionnaire (SPA-R; Martin *et al*., 2002) is a 25-items questionnaire, measuring athletes' attitude toward seeking sport psychology services. The SPA-R consists of four subscales: (a) Confidence in Sport Psychology (8 items), (b) Stigma Tolerance (7 items), (c) Cultural Preference (4 items), and (d) Personal Openness (6 items). The Confidence in Sport Psychology scale assesses athletes' beliefs about the usefulness of sport psychology and mental training. The Stigma Tolerance scale measures whether athletes believe that others will label them as having psychological problems if they seek assistance from a sport psychology consultant. The Cultural Preference assesses how much athletes identify with their own culture. Lastly, Personal Openness scale measure athletes' willingness to discuss their problem with sport psychologist. Respondents were asked to rate their attitudes and beliefs about sport psychology consulting on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Psychometric analyses found the SPA-R have adequate stability across various samples (Martin *et al*., 2002). SPA-R has established reliability and validity (Martin *et al*., 2002). In this study, the internal consistency estimates for the 7-item Stigma Tolerance ($\alpha = .83$), 8-item Confidence in Sport Psychology ($\alpha = .84$), 6-item Personal Openness ($\alpha = .64$), and 4-item Cultural Preference ($\alpha = .66$) subscales were all consistent with previous finding (Anderson *et al*., 2004). Scores for each SPA-R questionnaire factor are computed by summing the value of the items that load on each factor and dividing by the number of items of each factor. This score is reported for each factor as opposed to the total factor score to assist in the ease of comparison between scores on the factors (Harmison, 2000).

Procedure

Permission to conduct the study was obtained from the Ethical Committees of Universiti Sains Malaysia before the study was conducted. Once permission was granted by the relevant authorities, the athletes were recruited voluntarily participate in the study. A member of research team explained the purpose of the study, indicated what would be required from their participation, listed the anticipated risks and benefits of participation, addressed the issue of confidentiality of the participants' responses and emphasized that participation was voluntary. Informed consent was obtained from the athletes prior to the questionnaire administration.

The data collection process was completed in three sessions. Questionnaire was administered to the participants. A member of research team read instructions for completing the inventory. The instructions directed respondents to individually report their attitude and belief about sport psychology consulting. Participants have completed a set of questionnaire that consists of 5 parts questionnaire as described above. These questionnaire are available in both English and Malay language. The member of research team was available to answer any questions from the respondent. Respondents took approximately 15 minutes to complete the questionnaire.

Statistical Analysis

Analyses were conducted using Statistical Package for Social Science (SPSS) version 18.0. Descriptive statistics (mean, standard deviation, frequency and average) were used to screen and describe the sample. The differences between athletes of different competitive levels on their attitude scores were tested using independent t-test. p-values less than 0.05 (< 0.05) was considered as statistically significant.

RESULTS

Table 2: Characteristics of participants

	Mean (M)	***Std. Deviation (SD)***
Age	***16.51***	***2.11***
Completed years of sport participation	***5.12***	***2.53***
		Percentages (%)
Gender		
Male		***59.0***
Female		***41.0***
Race		
Malay		***92.6***
Chinese		***3.3***
Indian		***1.6***
Others		***2.5***

Attitudes towards Psychological Skill Training

Descriptive data for Sport Psychology Attitude-Revised (SPA-R) questionnaire are presented in the Table 3 below. The results indicated that the attitude towards sport psychology is generally positive (i.e., Stigma Tolerance; *M = 2.94, SD = 1.01* where a low score indicates positive attitude; Confidence in Sport Psychology Consulting *M = 5.12, SD = 0.82* where a high score represents positive attitude). The Personal Openness subscale had a moderately high score (*M = 4.82, SD = 0.85*) that displayed hesitation to discuss openly issues with sport psychologist. Athletes expressed some preference to working with a sport psychologist with the same cultural background (Cultural Preference *M = 3.84, SD = 1.12*) where a high score represents a high cultural preference).

Table 3: Attitude towards seeking sport psychology consultation

	Mean	Std. Deviation
Stigma Tolerence	2.94	1.01
Confidence to Sport Psychology	5.19	.82
Personal Openness	4.82	.85
Cultural Preference	3.84	1.12

Influence of Athletes Characteristics on Attitudes

Gender

Table 4 illustrates the score for male and female athletes for each subscale. There were no significant differences of attitude between male and female athletes on SPA-R scores ($p > 0.05$).

Table 4: Mean and Standard Deviation by Gender

	GENDER				t-value	p-value
	MALE (n = 72)		**FEMALE (n = 50)**			
	Mean	Std. Deviation	Mean	Std. Deviation		
Stigma Tolerance	3.00	.95	2.85	1.10	0.81	0.42
Confidence to SP	5.30	.80	5.03	.84	1.84	0.07
Personal Openness	4.75	.89	4.91	.79	-0.98	0.33
Cultural Preference	3.95	1.19	3.70	1.02	1.22	0.22

DISCUSSION

The findings of this investigation using SPA-R questionnaire suggested that the athletes in this study have confident in sport psychology services. Martin *et al*. (2002) suggested a mean score of over 5 on the Stigma Tolerance subscale would indicated a possible negative attitude by respondents towards seeking sport psychology consultation, and Malaysian athletes averaged only 2.94. This result suggests that these athletes did not perceive a stigma attached to working with sport psychologist and they also did not expect negative consequences of seeking sport psychology consultation. Contrary to Leffingwell *et al*. (2001) finding that stated athletes from the United States reported that the fear of being stigmatized was the primary reason for not seeking sport psychology assistance (Martin *et al*., 2004). The Personal Openness subscale had a moderately high score that displayed hesitation of Malaysian athletes to discuss openly personal issues with sport psychologist.

Comparison of the results from this present sample with mean data collected from athletes in Ireland (Lavallee *et al*., 2005), New Zealand (Anderson *et al*., 2004), the United States, Germany and United Kingdom (Martin *et al*., 2004) revealed that these Malaysian athletes held a generally positive attitude toward seeking sport psychology services as evidenced by higher average scores on Confidence in Sport Psychology subscale compared to United States, British and Germany athletes. This result represents Malaysian athletes' belief about the usefulness and importance of sport psychology and mental skill training. Besides, this result shows positive awareness of Malaysian athletes about pros and cons of sport psychology. The Malaysian athletes scored highest on Personal Openness subscale comparatively, suggesting athletes' unwillingness and inability to discuss openly their personal problems and concerns with sport psychologist (Martin, 2005). Athletes from Western countries were more open-minded due to different cultural ideologies they have. Whereas, Eastern societies have put greater value on their traditional social culture that

stress on protecting sense of self. This will hinder help-seeking in Malaysian athletes. Malaysian athletes also scored moderately high on Cultural Preference subscale suggesting identity to their own nationality, ethnicity, culture or race and have preference for working with a consultant from the same background. Contrary to Lavallee *et al*. (2005) who found that the Irish athletes identified with cultures other than their own.

Based on Theory of Planned Behavior proposed by Ajzen and Fishbein (1970), favorable attitude will lead to the formation of a behavioral intention. The attitude that athletes hold towards sport psychology will affect their intention to use and seek sport psychology services (Anderson *et al*., 2004). Generally, Malaysian athletes in this study have positive attitude towards seeking sport psychology services as evidence by high average scores on Confidence in Sport Psychology subscale. This shows that Malaysian athletes were not likely to be resistant to sport psychology. Theory of Planned Behavior is useful in understanding how perception will affect ones attitude, and its relationship with behavioral intention. The general rule of this theory is the more favorable attitude and subjective norm, and the greater the perceived control, the stronger should be the person's intention to perform the behavior in question.

Athletes' characteristics may influence athletes' willingness to seek sport psychology services provided and could have implication for how a sport psychologist may work with a specific group. Present findings, related to gender influence on athletes' attitude, contradict to the previous researches. Previous researches reported that individual differences in attitude towards sport psychology consultation were a function of gender. Female athletes were reported to have more positive attitudes compare to their male counterpart (Leffingwell *et al*., 2001; Martin *et al*., 2004; Anderson *et al*., 2004).

Results of this study indicated that gender did not significantly influence athletes' attitude. Malaysian female athletes were lack of personal openness most probably due to Eastern cultural norms that suggest that women should be able to tolerate and adversity in stoic silence. Rigid, sexist or restrictive gender role learned during socialization result in personal restriction of others and self (Good *et al*., 1995). Part of Eastern female gender role is not to talk about sensitive personal problem with outsiders and this may hinder reporting and help-seeking in Malaysian female athletes. Besides, Malaysian female athletes are less exposed to high performance sport. Athletes with more sport experiences tend to have broader view of sport psychology and are more confident to it benefits. Following the Theory of Planned Behavior (Ajzen, 1988), individuals are more likely to hold stronger attitude (positive or negative) toward a given topic when they are knowledgeable about the relevant information surrounding the topic (Hamberger *et al*., 2006). There are also questions of adequate rapport establishment and maturity of professional handling that can influence the study outcome.

Limitations

Some limitations should be noted when interpreting the current results. First, it must kept in mind that the data in this study are based on self-reported measures. It is difficult to ascertain if the questions were interpreted as desired, if the statements were answered truthfully, or if a particular response set was utilized. Results of the present study may not generalize to all Malaysian athletes. The sample used was not a random representation of all athletes in Malaysia, leading to possible threats to external validity. The study was done with insufficient data of Malaysian elite athletes. Due to limited excess to Malaysian elite athletes, the dataset do not represent overall Malaysian athletes population. Instead, the

athletes who participated were sampled by convenience and represented only a limited portion of the athletes in this country. Third, this study does not consider the type of sport that Malaysian athletes participated in. The type of sport that athletes have been socialized into and through may also play a role in athletes' attitude towards seeking sport psychology services. Therefore, it is possible that greater rigidity in gender-typing of sport activities may be demonstrated by athletes participating in only physical contact or traditionally masculine sports (Messner, 1992).

CONCLUSION

The findings of this study provide descriptive data on Malaysian athletes' attitude towards sport psychology services. The practical implication of this data is to assist sport psychology practitioners to develop and tailor interventions program that suitable and meet the need of athletes. Besides, it is importance to assess the effectiveness of the services provided. The sport psychology literature needs more information assessing how athletes think and feel about sport psychology (Martin, 2004).

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Effects of Consumption of a Beverage Containing Caffeine on Running Time Trial Performance

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Abstract

Previous studies on caffeine supplementation have indicated that it has an ergogenic effect in enhancing exercise and sports performance. The purpose of this study was to examine the effects of consumption of a beverage containing caffeine on running time trial performance and to determine selected physiological changes during the running endurance performance. Supplementation of caffeinated (C) beverage containing Nescafe 3-in-1 and Nescafe® decaffeinated (D) beverage as a placebo were given in a randomised cross-over study one hour prior to the actual experimental trials. Amount of caffeine in the caffeinated beverage was between 50-100mg. Eight male recreational runners (aged: 22 ± 0.8 years, VO_{2max}: 52.1 ± 3.3 $ml.kg^{-1}.min^{-1}$) from the Health Campus, Universiti Sains Malaysia participated in this study. Subjects were required to perform a 5-km running time trial on motorised treadmill. Heart rate, ratings of perceived exertion, body temperature and oxygen uptake were recorded at intervals of 10 minutes. Subjects' nude body weights were taken before and after the experimental trials. Time taken to complete the 5-km time trial was significantly ($p<0.05$) shorter in the C trial compared to the D trial (C= 28.2 ± 3.3 min vs D= 29.2 ± 3.4 min) respectively. Heart rate, ratings of perceived exertion and oxygen uptake increased over time in both the trials. However, there were no significant differences between trials. There was also no difference in body temperature between trials. The present findings show that consuming a caffeinated beverage (Nescafe 3-in-1) one hour prior to the experimental trials seems can improve the time trial performance of recreational athletes. However, it did not elicit any significant effect on heart rate, ratings of perceived exertion, body temperature and oxygen uptake during time trial performance.

INTRODUCTION

Ergogenic aids can be classified as nutritional, mechanical, pharmacological, physical and psychological, including legal and safe procedures such as carbohydrate supplementation, or even illicit and unsafe ones like anabolic steroids and blood infusion (Thein *et al*., 1995). Nutritional ergogenic aids are substances which enhance the athletic performance by influencing physiological as well as psychological process. Caffeine is one of the most

common ergogenic supplements in endurance sports (Wong *et al*., 2010). Caffeine is a methylxanthine found in coffee, tea, guarana, kola nut, chocolate and some soft drinks (Driskell, 2000). Caffeine (trimethylxanthine) is naturally occurring compound found in approximately 60 different plants. Caffeine and 3 dimethylxanthines (theophylline, theobromine, paraxanthine) are biologically active, and the putative impact of methylxanthines on metabolism has received considerable attention (Graham *et al*., 2008). Caffeine is arguably one of the most widely used ergogenic aids in the world, their intake can be in the form of different encapsulated, pilled, and powdered dietary supplements (Bloomer *et al*., 2011).

Caffeine is a popular material in the society that athletes use it for their physical preparation process and for contests (Rezaimanesh *et al.,* 2011). Endurance athlete is an athlete who participates in sports involving continuous activity (30 min to 4 hrs) and involving large muscle groups (Fink *et al*., 2006). For endurance sports three main factors-maximal oxygen consumption (VO_2max), the so-called 'lactate threshold' and efficiency (i.e. the oxygen cost to generate a give running speed or cycling power output)-appear to play key roles in endurance performance (Joyner and Coyle, 2008). Caffeine has been shown to enhance several different modes of exercise performance including endurance (Graham and Spriet, 1995;Graham *et al*., 1998; Pasman *et al*., 1995; McLellan *et al*., 2004), high-intensity team sport activity (Collomp *et al*., 1992; Glaister *et al*., 2008; Schneiker *et al*., 2006), and strength-power performance (Woolf *et al*., 1992; Beck *et al*., 2006).

Many research trials have demonstrated caffeine to be an ergogenic aid for exercise of varying intensities, durations and modalities in an athletic population (Bell and Mc Lellan, 2002; Doherty and Smith, 2005; Graham, 2001; Stuart *et al*., 2005). Benefits associated with caffeine ingestion in this population include delayed feelings of fatigue (Jackman *et al*., 1996), reduced sensations of pain and exertion (Bell and McLellan, 2002), increased time to exhaustion (Graham and Spriet, 1991), increased fatty acid oxidation (Chad and Quigley, 1989), increased mean power output (Anderson *et al*., 2000), decreased times to complete a set amount of work (Bridege and Jones, 2006), stimulation of motor activity (Fisone *et al*., 2004), as well as an increase in alertness, feelings of subjective energy and ability to concentrate (Keisler and Armsey, 2006).

The effect of caffeine on endurance has also been studied. Caffeine inhibits phoshotidiesterase by promoting catecholamine release and increase hormone-sensitive lipase activity, which leads to an increase of circulating free fatty acids and further improvement of endurance (Aoi *et al*., 2006). Caffeine has frequently been used in an acute way, previously to physical exercises, with the intention to delay fatigue and consequently improve athletic performance, especially in endurance activities (Delbeke, 1984; Jacobson, 1989). Many studies that have evaluated the ergogenic effect of caffeine on prolonged aerobic endurance tasks greater than one hour have shown beneficial effects. For example, a series of studies from Guelph University in Canada has suggested caffeine may enhance prolonged aerobic endurance performance through increased levels of epinephrine and sparing of muscle glycogen (Graham and Spriet, 1991; Spriet, et al., 1992).

Pasman and colleagues (1995) examined the effect of varying quantities of caffeine on endurance performance. Nine aerobically trained cyclist performed six rides to exhaustion at approximately 80% maximal power output. Subjects consumed four treatments on separate occasions: placebo, 5, 9, and 13 mg of caffeine/kg. body weight in capsule form. Results were conclusive in that all three caffeine treatments significantly increased

endurance performance as compared to placebo. Caffeine is effective for enhancing various types of performance when consumed in low-to-moderate doses (~3-6 mg/kg). Moreover, there is no further benefit when consumed at higher dosages (≥ 9 mg/kg) (Goldstein *et al*., 2010). Ingestion of 5mg of caffeine per kg of body weight improved the endurance running performance but did not impose any significant effect on other individual cardiorespiratory parameters of heat-acclimated recreational runners in hot and humid conditions (Wong *et al*., 2010).

Caffeine has been shown to primarily influence longer-duration endurance exercise by 20-50% (Spriet, 1995) and resting metabolic rate (Poehlman *et al*., 1985; Graham and Spriet, 1995). The majority of research has utilized a protocol where caffeine is ingested 60 min prior to performance to ensure optimal absorption. However, it has also been shown that caffeine can enhance performance when consumed 15-30 minutes prior to exercise (Goldstein *et al*., 2010). The effect of caffeine on endurance was reported in a study where there was a significant increase (44%) in endurance running performance after athletes ingested 9 mg/kg body mass of caffeine 1 hour prior to exercise (Graham and Spriet, 1991).

The present study was carried out to investigate the effects of consumption of a beverage containing caffeine on running time trial performance and selected physiological changes during the running endurance performance.

METHODS

Research Design

The subjects who participated in this study underwent a randomized placebo-controlled cross over study. The subjects were requested to perform two actual trials on the motorized treadmill after consuming caffeinated or placebo (decaffeinated) one hour prior to experimental trials. This was a single blinded study whereby the subjects did not have any knowledge about the beverage that they consumed before the experimental trial. The selection of the beverage containing caffeinated (Nescafe® 3-in-1) or decaffeinated beverage to the subjects was randomised.

Subjects

Eight male students from Universiti Sains Malaysia were recruited for this study. The subjects were selected based on their active participation in physical activity that is jogged at least 2 times per week. Their age range was between 20 to 25 years old. The nature and risk of the experiment procedures were explained to the subjects and a written informed consent was obtained from them. This study was approved by the Human Ethics Committee, Universiti Sains Malaysia.

Supplements

Subjects were required to consume 250 ml of Nescafe® drink (3-in-1, Rich) one hour prior to experimental trials. Amount of caffeine in each packet (20g) was between 50-100mg. Consumption of 250ml of Nescafe® decaffeinated drink were also given to the subjects one hour prior to experimental trials as a placebo.

Procedures

Subjects were required to perform two actual experimental trials in a randomized placebo-controlled cross over trial. They were also asked to refrain from ingesting any other products containing caffeine for 48 hours before the experimental trials and to refrain from strenuous exercise 24 hours prior to experimental trials. Subjects were required to record their food intake and physical activity for three days prior to the first trial. Then they were instructed to repeat the same diet over three days before the second trial to minimize the differences in muscle glycogen between trials.

Preliminary test and Familiarization trial

Preliminary test was used to establish maximal oxygen uptake. Subjects were requested to perform this test on a motorized treadmill using the Modified Astrand Protocol. This test required the subjects to run to exhaustion during continuous incremental run on the treadmill. Subjects were initially allowed to warm up for 5 minutes at a low speed (6-7 $km.h^{-1}$). After warm up, the subjects were fitted with the headgear, mouthpiece, nose clip and heart rate sensor. An appropriate speed (8-12 $km.h^{-1}$) was selected and the test began with a grade of 0% for 3 minutes. Thereafter, the grade was increased by 2½ % every 2 minutes and the subject was encouraged to run until exhaustion. Familiarization trial was performed for the purpose of familiarizing the subjects with the experimental protocol. The subjects were required to perform a 5 km time trial on a motorized treadmill.

Experimental trials

The experimental trials consist of performing two actual trials with a gap of seven days rest in between trials. For these experimental trials, subjects were requested to perform an endurance running time trial performance using the treadmill after supplementation of either caffeinated or decaffeinated beverage.

One hour before the experiment, subjects were requested to undergo a physical examination that included the measurement of nude body weight (after emptying their bladder), pre-exercise heart rate and body temperature. A heart rate monitor was secured in place onto subject chest to monitor his heart rate. The test dose 250ml of (caffeinated or decaffeinated) was consumed in random sampling method. All subjects were given a standardized breakfast an hour before beginning the experimental trials. During the experimental protocol, subjects were required to complete 5km in the shortest time possible. During the trials, heart rate, body temperature, room temperature, ratings of perceived exertion (Borg's Scale) and oxygen uptake was noted at intervals of 10 minutes. Body temperature was measured using an infra-red thermometer (Quick Shot Infra-Red Thermometer, Medihealth, USA).After the experimental protocol, subjects rested comfortably and nude body weight was taken after the subjects had towel-dried themselves. All the data were recorded in a form.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) software version 19.0 was used for analytical procedure. Normality was checked by Kolmogrov-Smirnov test. All the data were expressed as means ± standard deviation (SD). Two-way ANOVA with repeated measures

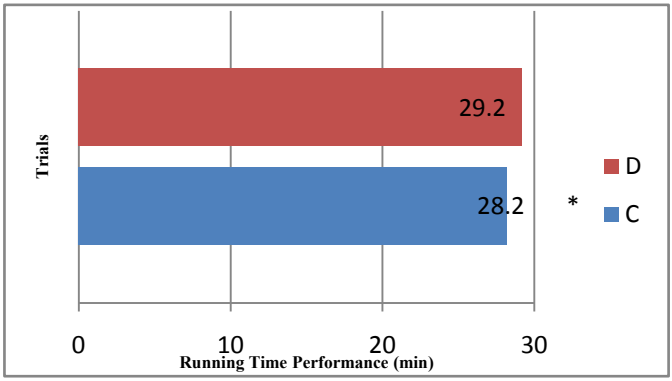
was used to determine the differences between trials and changes of the measured parameters over time. Statistical significance was accepted at $p < 0.05$.

RESULTS

Subjects' physical characteristics were tabulated in the Table 1. Endurance running performance was significantly shorter in the caffeinated (C) trial compared to the decaffeinated (D) trial. Time taken to complete the 5 km time trial in (C) and (D) trials was (28.2 ± 3.3 min vs 29.2 ± 3.4 min) respectively (Figure 1).

Table 1. *Physical Characteristics of the subjects. Values shown are means ± standard deviation.*

Parameters N=8	Means ± standard deviation
Age (years)	22.5 ± 0.8
Height (cm)	166.7 ± 3.8
Weight (kg)	58.9 ± 9.0
BMI	21.1 ± 2.7
Body fat (%)	15.7 ± 4.1
Maximum oxygen uptake ($mL.kg^{-1}.min^{-1}$)	52.1 ± 3.3



* Significantly different from the D trial at $p<0.05$

Figure 1. Time taken by the subjects in the caffeinated (C) and decaffeinated (D) trials.

Room temperature in both C and D trials was 23.4 ± 0.4 and 23.3 ± 0.5 °C respectively while relative humidity in both C and D trials was 57.8 ± 4.5 and 58.0 ± 4.1 % respectively. The changes in body weight were determined by comparing the pre and post exercise body weight in both of the trials. The changes in body weight for C trial were 0.7 ± 0.5 % and 0.8 ± 0.3 % in D trial..

Heart rate significantly increased over time in both C and D trials,. The mean heart rate of the subjects at the end of time trial in C and D were 193.9 ± 9.6 and 186.6 ± 8.8 beats.min[1] respectively (Figure 2). There were no significant changes in body temperature in both C

and D trials. The mean body temperature of the subjects at the end of time trial in the C and D were 36.2 ± 0.8 and 36.5 ± 0.8 ^{0}C respectively (Figure 3).

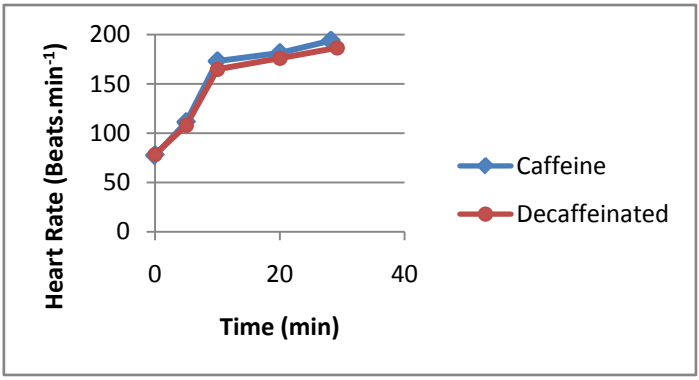


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Figure 2. Heart rate (beats.min^{-1}) of the subjects in the caffeinated (C) and decaffeinated (D) trials.

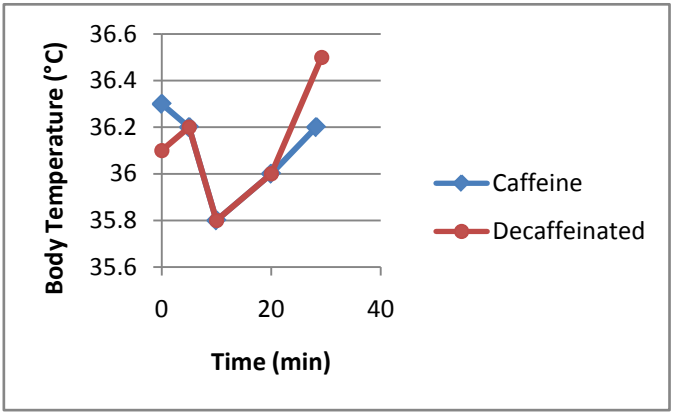

Figure 3. Body temperature (^{O}C) of the subjects in the caffeinated (C) and decaffeinated (D) trials.

Ratings of perceived exertion (RPE) significantly increased over time in both C and D trials. The mean RPE of the subjects at the end of time trial in the caffeinated (C) and decaffeinated (D) trials were 18.3 ± 2.4 and 18.6 ± 2.0 Borg's unit respectively (Figure 4).

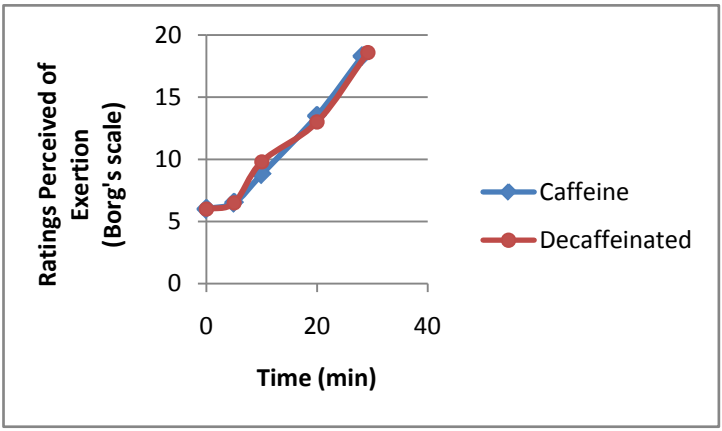

Figure 4. Ratings of perceived exertion (Borg's scale) of the subjects in the caffeinated (C) and decaffeinated (D) trials.

Oxygen uptake increased significantly over time in both C and D trials. The mean oxygen uptake of the subjects at the end of time trial in the caffeinated (C) and decaffeinated (D) trials were 48.5 ± 8.1 and 46.8 ± 8.0 ml.kg^{-1}.min^{-1} respectively (Figure 5).

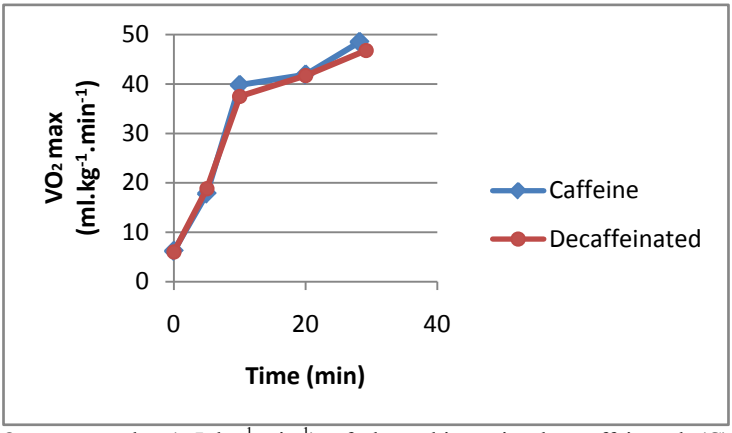

Figure 5. Oxygen uptake (mL.kg^{-1}.min^{-1}) of the subjects in the caffeinated (C) and decaffeinated (D) trials.

DISCUSSION

In the present study, the running time trial between C and D trials was significantly shorter ($p<0.05$) in C trial in comparison with D trial (Figure 1). Thus, the present study demonstrated that supplementation of caffeine seemed to have an ergogenic effect on 5-km running time trial performance. This finding of faster running time trial in caffeine

supplementation was also reported in other studies. For example, O'Rourke *et al*. (2006) reported that ingestion of 5mg kg^{-1} of body mass 1 hour prior to a 5-km running time trial significantly enhanced performance by decreasing the time to completion in both recreational and well-trained runners. In addition, the present finding was also similar to the findings of Wong *et al.* (2010) who also reported that ingestion of 5 mg of caffeine per kg of body weight one hour prior to experimental trials improved the endurance running performance but did not impose any effects on other cardiorespiratory parameters of heat-acclimated recreational runners in a hot and humid conditions. Recent, well-controlled studies have established that moderate doses of caffeine ingestion 1 hour prior to exercise, enhance the performance of certain types of endurance exercise in the laboratory. The reason behind this was because caffeine is rapidly absorbed, reaching peak concentrations in the blood within one hour of ingestion (Coleman, 2009).

The room temperature and relative humidity in this study were well controlled throughout the experimental trials since mean room temperature and relative humidity in C and D trials were similar (23.4 ± 0.4 ºC vs. 23.3 ± 0.5 ºC and 57.8 ± 4.5 % vs. 58.0 ± 4.1 % respectively). In the present study, mean oxygen uptake (VO_2) between both C and D trials was not different statistically at any time point. This indicated that both trials were performed at the same prescribed intensity. Heart rate increased significantly over time in both trials. Such gradual increase in heart rate over time was to meet the increasing requirement of the body during the endurance exercise (Wong *et al*., 2010). The present study demonstrated that there was no effect of a caffeinated beverage on exercising heart rate compared to the placebo trial. The possible reason could be due to the dosage of caffeine in the caffeinated beverage which contains only 50-100 mg of caffeine. Compared with the previous studies done with dosage of 5mg of caffeine/kg. body weight or more, the present dosage of 50-100 mg may not have elicited any physiological effect on the heart rate response. Nevertheless, differences in mode of exercise, duration, habituation to caffeine, hypertension status, and perceived stress could also be confounders (McClaran *et al*., 2007).

This study showed that there was no significant effect of caffeine on body temperature during the 5 km time trial performance. The possible reason could be due to the equipment used to measure the body temperature which was Quick Shot Infra-Red thermometer. This thermometer used the surface body temperature to detect the body temperature reading. Thus, any changes in the actual core body temperature could not have been detected.

During the experimental trials, the subjects were asked to judge their effort, which is referred to as ratings of perceived exertion. In the present study, it was found that there was no effect of caffeinated beverage on RPE compared to the placebo trial. This finding also corroborated with the study of Ahrens *et al.* (2007) who reported that the 6 mg/kg dose of caffeine did not affect RPE, HR or RER. This present result however was in a contrast with the finding of Costill *et al*. (1978) who reported that the best evidence supporting caffeine as a central nervous system stimulant was the decreased perception of fatigue during prolonged exercise in subjects who took caffeine. This finding can be explained possibly due to the intensity, duration and mode of exercise and also dosage of caffeine used during the present trials. It can be postulated that the lower dosage of caffeine in this present study which was 50-100 mg of caffeine, could be the possible reason why there are no effects in lowering RPE and increasing heart rate.

Oxygen uptake increases proportionately with the intensity of exercise to compensate the muscular demand during the activity (Antonio and Stout, 2001). The result obtained indicated that, there was no effect of caffeine on VO_2 during the time trial performance. This finding was similar with other studies (Trice and Heymes, 1995; Engels and Wirth, 1997; Soeren and Graham, 2001; McLellan and Bell, 2004; Wong *et al*., 2010). Therefore the present study revealed that consuming a caffeinated beverage containing 50-100 mg of caffeine did not affect VO_2 during the running time trial performance.

CONCLUSION

In the present study, under the experimental conditions set up for, it can be concluded that consuming a caffeinated beverage (Nescafe® 3-in-1) containing 50-100 mg of caffeine one hour prior to the experimental trials seems to improve the 5 km time trial performance of recreational athletes. However, the caffeinated beverage did not have any significant effect on heart rate, ratings of perceived exertion, body temperature and oxygen consumption during time trial performance.

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Effects of Combined Aerobic Dance Exercise and Honey Supplementation on Bone Turnover Markers in Women

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Abstract

Although combination of physical activity with supplementation has being investigated on its effects in maintaining and enhancing bone health, little is known about the effectiveness of combination of aerobic dance exercise with honey supplementation on bone metabolism markers in women. This study investigates the effects of 8 weeks of combined aerobic dance exercise and honey supplementation on bone metabolism in women. Forty four healthy sedentary women (25-40 year-old) were age and weight matched, and subsequently being assigned into four groups with n=11 per group: Control (C), honey supplementation (H), aerobic dance exercise (Ex) and combined aerobic dance exercise with honey supplementation (HEx) groups. Aerobic dance exercise was carried out for one hour /session, three times/week for eight weeks. Honey drink was consumed by H and HEx groups, in a dosage of 20g of honey diluted in 300ml of plain water, for 7 days/week for 8 weeks. In HEx group, the subjects were required to consume honey drink 30 minutes before performing exercise. Before and after 8 weeks of experimental period, blood samples were taken to determine the concentrations of serum total calcium, bone osteocalcin (bone formation marker) and serum C-terminal telopeptide of type 1 collagen (1CTP) (bone resorption marker). After 8 weeks of experimental period, there was significant greater serum total calcium in post test than pre test in H group. Serum 1CTP concentration was significant greater in post test than pre test in Ex group. The percentage increment in 1CTP was the highest in Ex group, and the percentage increment in this parameter was the lowest in HEx group among all the experimental groups. The results of present study suggest that combination of aerobic dance exercise and honey supplementation may elicit effects on reducing the increment in bone resorption resulting from exercise in sedentary women.

INTRODUCTION

To date, many treatments have been developed with the aim of preventing bone loss and increasing bone mass, these include involvement in physical activity programmes (Morris *et al*., 1997) and through adequate nutritional intake (Craciun *et al*., 1998; Kehoe, 2006).

Maximising peak bone mass may reduce the risk of osteoporotic fracture in later life, and weight bearing exercise during growth can enhance peak bone mass (Matthews *et al*., 2006). Continuation of weight-bearing exercise after growth is believed can prevent excessive bone loss in adults. Heinonen *et al*. (1999) reported that there were significant increases in bone mineral density by a supervised 18 month high impact training, the exercise-induced beneficial bone effects were effectively maintained with subsequent unsupervised regular aerobic and step exercises which were carried out twice per week in premenopausal women.

Numerous previous studies have investigated the influence of exercise and mechanical load on bone tissue (Peng *et al*., 1994; Barengolts *et al*., 1993). According to Rittweger (2006), the mechanical strain generated by exercise constitutes one of the most important stimuli to bone formation. Bone tissue responds better to dynamic exercises (Barengolts *et al*., 1993) such as those consisting of jumps, rather than static loading (Robling *et al*., 2002, Turner and Robling, 2003). Dancing may provide an ideal osteogenic stimulus, particularly at the hip region, because the various jumps and landings that typify dancing impart unusual and ranging from low to high-impact loads on the skeleton. These loads are experienced primarily in the lower limbs (Khan *et al*., 1998).

Bones continues to renew themselves even after reaching their adult shape and size. Bone remodeling which is also known as bone turnover is an ongoing process, whereby osteoclasts first carve out small tunnels in old bone tissue and then osteoblasts rebuild it. The purposes of remodeling is, to renew bone tissue before deterioration sets in, and redistributes bone matrix along lines of mechanical stress which allows the bone to adjust it strength through the strategically placing. The breakdown of matrix by osteoclasts is called bone resorption. Once a small area of bone has been resorbed, osteoclasts depart and osteoblasts move in to rebuild the bone in that area. In order to achieve homeostasis, bone resorbing actions of osteoclasts must balance the bone making actions of osteoblasts (Tortora and Grabowski, 2003). It is generally known that specific biochemical markers of bone turnover allows for an estimate of bone metabolic process and they have been established as useful parameters in assessing changes in bone turnover (Souberbielle *et al*., 1999; Leo *et al*., 2000). In the present study, serum osteocalcin was measured as biomarker of bone formation, and C-terminal telopeptide of type 1 collagen (1CTP) was measured as biomarker of resorption.

Besides regular weight-bearing exercise, nutrition also plays an important role in enhancing and maintaining bone health. Honey contains moisture, sugars such as glucose and fructose, enzymes, trace essential elements such as iron, copper, zinc and calcium and vitamins such as vitamin A, C and E (Al-Waili, 2003). These elements are believed to be beneficial for maintaining and enhancing bone health. It was reported that a group of researchers from Purdue University, U.S.A. has shown in their preliminary study that taking honey along with supplemental calcium appeared to enhance calcium absorption in rats, and could therefore play a role in boosting bone health (Philip, 2005). Additionally, in another study, it was found that in a group of young Sprague Dawley rats fed with honey for 52 weeks, their bone mineral density were significantly greater than the sugar free diet-fed controls (Chepulins and Starkey, 2008), this again indicates that honey may enhance bone health. In a recent animal study carried out by the present research team, it was found that there were beneficial bone effects elicited by combined jumping exercise and honey supplementation on bone physical and mechanical properties, and bone metabolism in female rats (Tavafzadeh, 2009; Ooi *et al*, 2010; Tavafzadeh *et al*., 2011).

Aerobic dance exercise has been shown to be effective in producing great osteogenic effects (Khan *et al*., 1998; Matthews *et al*., 2006). It is one of the weight bearing exercises which requires ones to work against gravity and involves low, moderate and high impact or load activities. It is believed that aerobic dance exercises can help to develop and maintain strong bone. In a recent human study carried out by the present research team, it was found that 6 weeks of combined aerobic dance exercise and honey drink supplementation elicited more beneficial effects on bone health by increasing blood bone formation marker in 19 to 29 years old young females compared to honey supplementation alone or exercise alone (Ooi *et al*., 2011). This recent previous study indicated that six weeks of aerobic dance exercise at three times per week, one hour per session combined with daily consumption of 20g of honey diluted in 300 ml of plain water, may enhance bone health in the young female subjects. Nevertheless, to date, the combined effects of combined aerobic dance exercise and honey drink supplementation on bone health in older population have not been investigated. Therefore the present study was proposed for determining the effectiveness of combination of aerobic dance exercise and honey supplementation on bone turnover markers in adult women with age ranging from 25 to 40 years-old.

METHODS AND MATERIALS

Subjects

In this study, forty four physically healthy women, age ranges from 25 to 40 years old were recruited. Subjects recruited in this study were sedentary, free from health problems and did not have a habit of consuming honey supplementation daily before the recruitment. Subjects were matched in age, body mass, height and percent of body fat before they were assigned into the intervention groups and one control group with 11 subjects per group (n=11).

All subjects were fully informed by the researcher about the nature of the experiments, purpose of the study, procedures, benefits, risks of feeling discomforts experienced in this present study before giving their formal consent. The present study was approved by the Research Ethics Committee (Human) of Universiti Sains Malaysia. Participation of a subject in this study was on a voluntary basis and they were allowed to withdraw from this study at any time during the course of this study.

Experimental Design

Subjects' grouping

The subjects were randomly divided into four groups with 11 subjects per group (n=11): 8 weeks of sedentary without supplementation control (C), 8 weeks of aerobic dance exercise (Ex), 8 weeks of honey supplementation (H), and 8 weeks of combined aerobic dance exercise and honey supplementation (HEx) groups. Subjects in the control group (C) did not perform neither exercises nor taking honey supplementation. Meanwhile, aerobic dance exercise group (Ex) performed one hour aerobic dance exercise per session, 3 times per week for 8 weeks. Subjects of honey group (H) consumed 20g of Gelam honey which was diluted in 300ml of plain water, for 7 days per week for a total of 8 weeks duration. Subjects in combined aerobic dance exercise with honey supplementation group (HEx) performed aerobic dance exercises one hour per session, 3 times per week for 8 weeks and consumed Gelam honey drink 7 days/week for 8 week with dosage same as honey group.

The subjects of HEx were required to consume honey drink 30 minutes before performing aerobic dance exercise on the exercised days.

Blood sample taking

Before and after the 8 weeks of exercise / supplementation / combined / sedentary without supplementation periods, subjects were seated and 8ml of venous blood sample was taken from an antecubital vein after a 8 hour overnight fast (drinking plain water is allowed). The blood was withdrawn by the laboratory technologist in the Sport Science Laboratory, School of Medical Science, Health Campus, Universiti Sains Malaysia to determine the bone metabolism markers. Blood taking for subjects in Ex and HEx were carried out 13 - 16 hours (8.00 - 10.00a.m) after performing aerobic dance exercise.

Serum from the clotted blood in the plain tube was used for determining serum bone turnover markers. Serum was obtained by centrifuged the blood sample using a centrifuge (Hettich-Rotina 46RS, Germany) for 10 minutes with 4000 rpm, before being divided into equal portions and stored at -80^0C in a freezer (ThermoForma, Model 705, USA) for subsequent analysis.

Blood biochemical analysis

Serum total calcium was analysed calorimetrically using an automatic analyzer (Hitachi Automatic Analyzer 912, Bohringer Mannheim, Germany) with commercially available reagent kits (Randox, UK). Serum osteocalcin, a bone formation marker, was analysed using a commercially available enzyme immunological test kit (N-MID® Osteocalcin ELISA), and the concentration was determined using a photometric microplate reader (Molecular Devices; Versamax tubable microplate reader, U.S.A.). Serum C-terminal telopeptide of type 1 collagen (1CTP), a bone resorption marker, was analysed by a quantitative enzymeimmunoassay kit Orion Diagnostica UniQ 1CTP EIA, Finland, and the concentration was determined by a photometric microplate reader (Molecular Devices; Versamax tubable microplate reader, U.S.A.)

Aerobic dance exercise programme

The subjects of aerobic dance exercise group (Ex) and combined honey supplementation with aerobic dance exercise group (HEx) were required to attend aerobic dance classes for 3 sessions per week, one hour per session (from 5.30pm to 6.30pm) for 8 weeks.

This aerobic dance exercise programme of this study consisted of 2 sessions of 'high impact and low impact' and one session of a 'step board' aerobic dance exercises in a week. The one hour session started with 10 - 15 minutes of warming up period, 30 - 35 minutes of cardio period and ended with 5 - 7 minutes of conditioning, toning and cooling down.

The aerobic dance exercise programme prescribed in the present study generally involved continuous, controlled movement of the legs and trunk, and intermittent movement of the arms. These include movements such as side stepping, fast walking, forward and backward stepping, leg lifts, placing foot to the front, side and behind, knee bends, forward and side-lunging, heel rises and also some high impact exercises such as jumping. In the 'step board' exercise sessions, subjects were required to step up and step down the step board while dancing. The intensity of aerobic dance exercise was estimated by using heart rate monitor

(polar watch, S710, US) wore by a few subjects throughout the dancing sessions. Besides, the subjects were given pre-recorded CD containing aerobic dance workout, and they were required to follow the workout in the CD given at home if they missed any of the aerobic dance sessions.

Honey supplementation

Honey drink was consumed by the subjects in the honey (H) group, and combined aerobic dance exercise and honey supplementation (HEx) group in the dose of 20 g of honey (Mahaneem *et al*., 2011; Sulaiman *et al*., 2011) diluted in 300ml of plain water (Gisolfi and Duchman, 1992), for 7 days per week for a total of 8 weeks duration. Gelam honey, which is a local Malaysian honey contributed by Federal Agriculture Marketing Authority (FAMA), Malaysia was used in this study. In the combined aerobic dance exercise and honey supplementation (HEx) group, the subjects were required to consume honey drink 30 minutes before performing aerobic dance exercise on the exercised days.

Statistical analysis

Statistical analysis was done by using Statistical Package for Social Science (SPSS) version 18.0. Mean and standard deviation (SD) of the experimental data was calculated, and data was reported as mean ± SD. Repeated measure analysis of variance (ANOVA) was performed to determine the significance of the differences between and within groups. Difference is considered significant at $p < 0.05$.

RESULTS

From a total of 44 subjects recruited, 40 healthy sedentary adult women with mean age 29.7 ± 5.37 years completed the present study. Two subjects from honey supplementation group (H) and two subjects from combined honey supplementation with aerobic dance exercise group (HEx) unable to continue this programme due to pregnancy and unknown reasons during the experimental period. There were no significant differences between groups in age, body mass, height and percentage of body fat at the beginning of the experimental period (Table 1).

Table 1: Mean age, body height, body mass and percentage of body fat of the subjects (Mean ± SD)

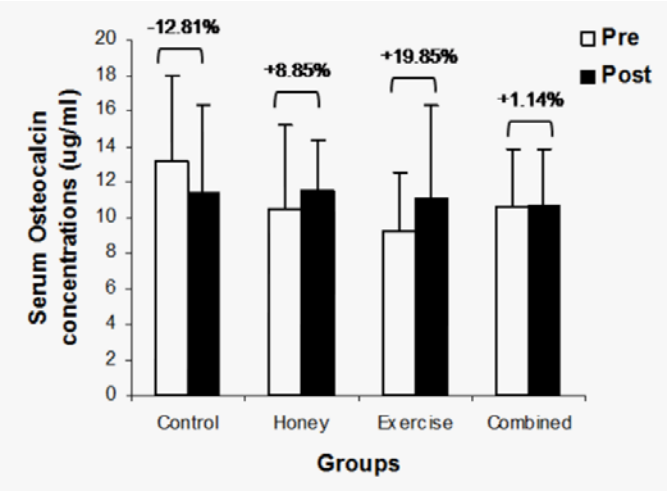
Groups	Age (Years)	Body height (cm)	Body mass (kg)	Percentage of body fat (%)
Control (C)	27.5 ± 3.8	154.2 ± 5.6	56.0 ± 9.9	32.5 ± 9.8
Honey (H)	30.4 ± 5.0	153.8 ± 4.8	54.5 ± 7.8	33.0 ± 7.2
Exercise (Ex)	31.2 ± 6.1	154.6 ± 6.1	55.3 ± 5.0	32.7 ± 5.0
Combined (HEx)	29.9 ± 6.4	156.4 ± 6.0	53.4 ± 7.7	30.0 ± 7.4

The study results showed that there was statistically significant greater post test value of serum total calcium than pre test value in H group (**Table 2**). The percentage increment in osteocalcin, a bone formation marker in Ex group was the highest (+19.85%) compared to the other experimental groups (Figure 1). Serum 1CTP concentration was significant greater in post test than pre test in Ex group. The percentage increment of serum 1CTP concentration was the highest (+40.51%) in Ex group, and the percentage increment of this parameter was the lowest (+14.75%) in HEx group among all the experimental groups (Table 3).

Table 2: Mean serum total calcium concentration (Mean ± SD)

Groups	Serum total calcium concentration (mmol/l)			Percent difference compared to pre test (%)
	Pre Test	Post Test	Mean difference between pre- and post tests	
Control (C)	2.32±0.09	2.35±0.05	0.03±0.08	1.29
Honey (H)	2.30±0.05	2.40±0.11*	0.10±0.10	4.35
Exercise (Ex)	2.38±0.18	2.34±0.10	-0.05±0.14	-2.10
Combined (HEx)	2.29±0.14	2.33±0.07	0.04±0.11	1.75

**P<0.05 significantly different from pre test*



*p<0.05 significantly different from pre test

Figure 1. Mean serum osteocalcin concentrations at pre- and post tests (Mean ± SD)

Table 3: Mean serum C-terminal telopeptide of type 1 collagen (1CTP) and parathyroid hormone concentrations (Mean ± SD)

Groups	Serum 1CTP concentration (µg/ml)			Percent difference compared to pre test (%)
	Pre Test	Post Test	Mean difference between pre- and post tests	
Control (C)	2.33±0.93	3.05±1.30	0.73±1.19	30.90
Honey (H)	2.60±0.92	3.10±1.25	0.50±1.12	19.23
Exercise (Ex)	1.95±0.85	2.74±1.06*	0.79±1.06	40.51
Combined (HEx)	2.44±0.94	2.80±1.07	0.36±1.17	14.75

**P<0.05 significantly different from pre test*

DISCUSSION

The present study found that there was significant increase in serum total calcium after 8 weeks of exeperimental period in H group. The percentage increment in osteocalcin, a bone formation marker was the highest in Ex group among all the experimental groups. Meanwhile the percentages increment in 1CTP, a bone resorption marker in HEx group were the lowest among all the experimental groups. In general, the present findings showed that honey supplementation alone could significantly elevate serum total calcium level, whereas aerobic dance sessions alone could significantly elevate bone resorption. It is interestingly to observe that combined aerobic dance exercise and honey supplementation showed its potential in reducing bone resorption induced by exercise.

Biochemical markers of bone turnover have large diurnal and seasonal variation. Differences in blood analysis results may reflect differences in osteoblastic activity. Therefore, Lehtonen-veromaa *et al*. (2000) mentioned that the sampling time is crucial for interpretation of blood analysis results Several previous investigations have reported the changes in the serum concentrations of bone biomarkers during exercise (Brahm *et al*., 1997; Welsh *et al*., 1997), immediately after exercise (Thorsen *et al*., 1996; Brahm *et al*., 1997; Welsh *et al*., 1997) and followed up post exercise (Thorsen *et al*., 1996; Welsh *et al*., 1997; Ballard *et al*., 2005; Evans *et al*., 2007) for reflecting bone metabolism. In the present study, the exercise sessions were carried out from 5.30 p.m. to 6.30 p.m., and the blood taking sessions were carried out at 8.30 the next morning, i.e. 14 hours post exercise. Thus, the blood analysis results of the present study indeed represent the status of bone turnover markers 14 hours after exercise.

Regarding effects of honey supplementation on bone, Chepulis and Starkey (2007) found that bone mineral density was significant increased in honey-fed rats compared with those fed with sugar-free diet. Their results reflect that honey supplementation alone may elicit beneficial effects on bone health. Since changes in bone mineral density are expected may not be observed in a short duration of 8 weeks, therefore the present study focused on

changes in blood parameters, where changes in blood bone turnover markers such as serum alkaline phosphatase as bone formation marker, and serum C-terminal telopeptide of type 1collagen (1CTP) as bone resorption marker were observed. In the present study, the significant increase in serum total calcium after 8 weeks of study period in the honey supplementation alone group implies that the daily honey supplementation for a duration of 8 weeks enable to increase blood calcium level, nevertheless, statistical significant changes in bone turnover markers were not observed.

In the exercise alone group in the present study, significant increase in serum 1CTP was observed, and the percentage increment of 1CTP was the highest among the groups. Additionally, a non-statistically significant elevation of serum osteocalcin was observed in this group, and the percentage increment of osteocalcin of this group was the highest among the groups. This observation reflect that aerobic dance sessions which were conducted three times per week for a duration of 8 weeks may have potential to enhance both bone formation and resorption, i.e. one's bone turnover.

In the combined aerobic dance exercise with honey supplementation group, the percentage increment of serum 1CTP was the lowest among groups. This finding implies that this combination may elicit beneficial effect in reducing the increment of bone resorption induced by exercise. Consistent with the findings of this present human study, in our recent previous animal study, Tavafzadeh (2009) also showed that 8 weeks of combination jumping exercise and honey supplementation could significantly reduce the bone resorption marker of 1CTP in rats.

Consumption of honey which contains calcium may increase calcium availability in the blood as evidenced in the honey supplementation alone group. It is speculated that during aerobic dance exercise in the present study, higher volume of blood would be delivered to the working muscles. Thus, the enhancement of calcium level in the peripheral blood due to honey drink ingestion and involvement in exercise may have caused reduction in bone resorption which can be reflected by 1CTP levels as can be observed in the present study. According to Ososki and Kennelly (2003), phenolic compounds in plants which are termed as phytoestrogens can possess oestrogenic activity, and it is present in honey (Gheldof *et al*., 2002, Mohamed *et al*., 2010). Eastell (2005) mentioned that the rise in oestrogen levels at menarche in girls is associated with a large reduction in bone turnover markers. The effect of oestrogen on bone remodeling is to decrease activation frequency and subsequent decrease the numbers of osteoclasts and osteoblasts. These facts could be the factors which can affect the effects of honey on bone turnover markers in the present study.

Regarding effects of combined exercise and nutritional supplementation, Evans *et al*. (2007) has investigated the combination effects of protein and exercise in postmenopausal women. They found that dietary supplementation with soy decreased bone resorption and formation, whereas moderate intensity endurance exercise training did not alter bone resorption, and there were no apparent additive or synergistic effects of soy and exercise on markers of bone turnover. The absence of beneficial effects of combined nutritional supplementation and exercise in their study as compared to the present findings could be due to differences in the type of supplementation and exercise prescribed, and the age of the subjects recruited.

CONCLUSION

In conclusion, the present study found that combination of aerobic dance exercise and honey supplementation may elicit beneficial effects on reducing bone resorption induced by exercise in sedentary women. Therefore, supplementation of honey drink with 20g of honey diluted in 300ml of plain water combined with 3 days per week of aerobic dance exercise has potential to be proposed for formulating guidelines in planning exercise and nutrition promotion programmes for the maintenance of bone health in sedentary women.

ACKOWLEDGEMENTS

This work was supported by Fundamental Research Grant Scheme (FRGS) (Grant number: 203/PPSP/6171143). We would like to thank all the subjects for their cooperation in this study. The Gelam honey used in the present study was sponsored by Federal Agricultural Marketing Authority (FAMA) of Malaysia, and the arrangement for this sponsorship by Assoc. Prof. Dr. Siti Amrah Sulaiman is very much appreciated.

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Gender Differences in Responsiveness to *Ashwagandha* Supplementation on Physical Performance of Elite Indian Cyclists

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Abstract

Ashwagandha or also known as Withania Somnifera is an ayurvedic herb known to possess many medicinal and vitality boasting properties. Studies have shown improvement in both aerobic and anaerobic power upon Ashwagandha supplementation. However, there is paucity in literature whether this effect are similar in both; well-trained males and females. Hence the present study was devised to study the gender differences in effect of Ashwagandha supplementations on physical performance of elite Indian cyclists. Study design was an experimental, same subject design. This study was done on thirty-eight cycling athletes (n = 38), compromised of 19 males and 19 females with mean age of 20.5 ± 2.0years. The subjects were then randomly divided into experimental and control group. Aerobic capacity parameters that were directly measured was MET's and VO_2 max, running on the Bruce protocol. Anaerobic parameters were watts, average power and peak power measured on 40cm Box-Jump test using the Kinematic Measuring System (KMS). The experimental group was given 8 weeks supplementation of Ashwagandha supplementation in the form of capsules containing aqueous extracts of roots while the control group was given starch capsules and the post readings were noted after 8 weeks.Results indicated that VO2max improved significantly in males ($P<0.001$), while average power and peak power significantly improved in females ($P<0.01$). 8 weeks of Ashwagandha supplementation improves the aerobic capacity in males while anaerobic capacity in females.

INTRODUCTION

Ashwagandha, also known as *Withania Somnifera* or Indian winter cherry, has been an important traditional herbal medicine for over 3000 years*(Mishra et al, 2000)*. Its root contains flavonoids and many active ingredients like alkaloids and steroidal lactones, which are commonly called *Withanolides*. The chemicals constituents of Ashwagandha include three natural powerful antioxidants; superoxide dismutase, catalase and glutathione peroxidise. It is an ingredient in many formulations prescribed for a variety of musculoskeletal conditions (e.g., arthritis, rheumatism), and as a general tonic to increase energy, improve overall health and longevity, prevent disease, in athletes, elderly and during pregnancy *(Archana et al, 1999)*. Several studies have suggested that Ashwagandha improves the hemoglobin count (Hb) and red blood cell count (RBC) *(Ziauddin et al 1996)*, which is an important factor which determines the cardiovascular performance of an elite

athlete *(Reeves, 2003)* Since the increase in RBC mass leads to increase in bloods capacity to transport oxygen *(Mc Ardle, 1996)*, at a greater capacity to the peripheral system thus ensuring a greater VO2 max. Another study was done by *Sandhu et al in 2010* on young sedentary adults which suggested improvement in VO2 max and anaerobic power after 8 weeks of Ashwagandha supplementation.

Cycling is regarded as an endurance sports that mainly relies on the aerobic capacity for energy generation during sustained bouts (*Rogers et al, 1997)*. Though, the aerobic process supplies most of these adequate amounts of energy required in long lasting races, yet they do not provide adequate amounts of energy during strenuous exercise, in which conditions, the important energetic requirements are supplied by the anaerobic pathways (*Crielaard et al, 1981*).

The anaerobic power production for the sprint dominance is crucial to these cyclists during the last minute of the race, wherein sprint power generated by the anaerobic energy system guides the cyclist through the finishing line and drives him to grab a podium finish *(Martin et al, 2007)*. A study done by Sandhu et al in 2012 also had found out that Ashwangandha improves both aerobic and anaerobic capacity of the cyclist , however there have been no studies to determine whether these effects are similar in both; well-trained males and females. Hence the present study was devised to study the gender differences in effect of Ashwagandha supplementations on physical performance of elite Indian cyclist.

METHODS

Research Design

An experimental, same subject design was employed for the present study. Subjects were then randomly divided into experimental and control group. Experimental group was given 8 weeks supplementation of Ashwagandha supplementation in the form of capsules containing aqueous extracts of roots while the control group was given starch capsules and the post readings were noted after 8 weeks.

Subjects

This study was done on thirty-eight cycling athletes (n = 38), compromised of 19 males and 19 females with mean age of 20.5 ± 2.0 years. The subjects were then randomly divided into experimental and control group. Aerobic capacity parameters that were directly measured was MET's and VO_2 max, running on the Bruce protocol. Anaerobic parameters were watts, average power and peak power measured on 40cm Box-Jump test using the Kinematic Measuring System (KMS). The experimental group was given 8 weeks supplementation of Ashwagandha supplementation in the form of capsules containing aqueous extracts of roots while the control group was given starch capsules and the post readings were noted after 8 weeks. The subjects were recruited from the elite team from Guru Nanak Dev University's (GNDU) Cycling Team, in which should have minimum requirements and achievements categorizing them to elite cyclist (national or Commonwealth Games participation). All subjects were informed about the experimental design and protocol and the possible risks before giving informed written consent. The study was approved by the Institutional Ethical Committee of the Guru Nanak Dev University.

Supplements

Ashwagandha supplementation

The *Ashwagandha* (*W. Somnifera*) used was in the form of standardized aqueous root extract, which was obtained in the form of capsules from Dabur India Limited. This had been standardized to the in-house specifications of Sanat Products Limited, the vendors of Dabur India, certified by the Government of India, Ministry of Health and Family Welfare, Department of AYUSH, with the purchase order no. 4500579974, challan no. 291, and receipt no. 5000427895. The supplementation was in the form of 500 mg gelatin capsules. The capsules were given over eight weeks, at a dosage of two capsules (each capsule containing 500 mg) a day, 1,000 mg/day (taken daily in the morning and evening).

Placebo supplementation

In this study, the placebogroup was supplemented equally with placebo capsules containing starch powder for the duration of eight weeks. These capsules were also prepared by the same company (Dabur India Ltd.).

Procedures

Basic demographic data of each subject was noted, which included age, sex, date of birth, personal best achievements (graded from scale 1-5), height (cm); using the stadiometer pole; precision of 1mm and weight (kg); using the Seca scale; precision of 0.1kg.

Assessment of VO_2 Max

A graded exercise test (GXT) was performed on a treadmill; FitNex 200 Treadmill, running on the Bruce Protocol in which subjects were asked to perform till volitional stage. This GXT test was performed pretest to feeding of the Ashwagandha supplement and post-test, upon completion of 8 week intervention.

All participants completed the GXT (involving the protocol, electronic heart rate monitor, full nose-mouth piece and rating of perceived exertion (RPE); Borg Scale (1982) were given to all participants prior to testing.

During the maximal GXT, metabolic gasses were collected using the Vista MX-Turbofit metabolic measurement system.The VO_2 Max and respiratory exchange ratio (RER) was computed, averaged and saved by a computer system every 15 seconds. The participants exercise heart rate (HR) and RPE score was recorded at the end of each stage. VO_2 max was considered valid when at least two of the following three criteria were met. (ACSM 2000; Howley, Basset & Welch, 1995):

1. Maximal heart rate within 15 beats of age predicted maximal heart rate
2. Respiratory exchange ratio equal to greater than 1.10
3. Plateau in VO_2 despite an increase in work load.

Assessment of Power

For these, the Kinematic Measuring System (KMS) from Fitness Technology; Australia was used to measure average power and absolute peak power of the lower limbs. The 40 cm box-jump test was used to get the average power and absolute peak power of lower limbs. The protocol used was the 30-second box jump test, whereby subjects were required to do a continuous jump from one end, to the top of the box, then landing on the other side of the box and finally returning to the beginning point. This had to be repeated non-stop for the duration of 30-seconds. Upon completion of the test, KMS will count the repetitions and display the total and segment count, total work done, average and peak power output (units

displayed in Watts). Subjects were given 3 attempts, whereby the best reading of 3 trials were taken. Subjects were given an orientation session for the 40-cm box jump on a separate day, as well as 1–2 practice attempts, prior to the day of testing.

Assessment of Velocity

In this test procedure, the 50-meter Dash Test was used. Subjects were required to sprint a straight dash of a distance of 50-meters and the time (seconds; s^{-1}) was recorded. Subjects were given 3 attempts, whereby the best reading of 3 trials were taken. Subjects were also given an orientation session before the start of the test, as well as 1–2 practice attempts.

Statistical Analysis

All statistical analyses was performed using Microsoft Office 2011; Excel and Statistical Package for Social Sciences (SPSS) version 16.0.The Levene's test was used to analyze the data for the level of significance. Relating values of 't' test was used to find intragroup and Levene's was used to find intergroup differences in pre and post protocol. As for 't' test of comparison between male vs. females, One-Way ANOVA and Post-Hoc Scheffe's Test was used. The *P* value used for statistical significance was 0.05 for all cases and entire results are expressed as means ± standard deviation (SD).

RESULTS

Subject's baseline physical characteristics and physiological profile were tabulated in the Table 1.

Table 1: Physical characteristics and physiological profiles of the subjects.

Measures (n=17)	Age	Weight	Height	VO2 MAX	HR MAX
Males	20.06 ± 1.5	59.8 ± 9.5	171.2 ± 7.5	51.35 ± 6	184.4 ± 24.3
Females	20 ±2	52.1 ± 4.7	161.7 ± 6.1	40 ± 8.9	178.8 ± 20.7

Values are means ± standard deviation.

As for males, mean age was (20.06 ± 1.5), weight of (171.2 ± 7.5) VO2 Max of (51.35 ± 6) and heart rate max of (184.4 ± 24.3). Whereas for females baseline parameters that were recorded was (20 ± 2) for age, (52.2 ± 4.7) for weight, (40 ± 8.9) for VO2 max and heart rate max of (178.8 ± 20.7).

Table 2 shows the percentage differences of males and females upon the intervention of the Ashwagandha supplementation of 8-weeks. Table shows in comparison of experimental and control groups. For the males group, there was a significant difference of 10.7% increase in time to exhaustion and increase in VO2 Max of 16.1% with the METS of 15.8% in the experimental group. Whereas in females, a significant improvement was seen in the experimental group in parameters of WATTS with 28.5% increment, Average power (box jump) with 13.2% and Peak Power (box jump) with an increase with 9.7%.

Table 2: Percentage (%) Differences of Males and Females Experimental vs Control, respective to Variable

MALES		Variables	FEMALES	
Experimental	Control		Experimental	Control
10.7	-0.9	Time (mins)	4.3	1.1
16.1	3.7	VO2 Max (ml/kg/min)	9	-4.2
1.8	-0.9	RER	1.5	-2.5
2.8	2.7	HR MAX	1.9	7.1
15.8	3.2	METS	7.6	-4.8
17.8	-3.1	WATTS	28.5	1.1
6.7	-0.6	VE (stpd)	8.3	-1.9
11.4	-3.9	Box Jump (Av. Power)	13.2	-1.1
8.7	-2.4	Box Jump (Peak Power)	9.7	-0.8
-6.4	-3.2	50m Dash (m/s)	-3.7	-1.5

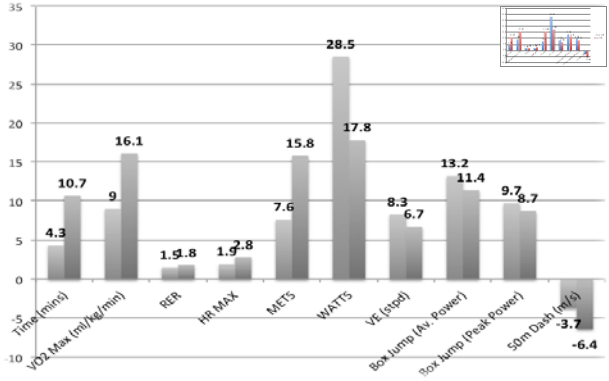
Table 3 illustrates the pre-post readings of males and females in the experimental group. Hereby its seen that time to exhaustion was significant with (P<0.01), VO2 max and METS significant with (P<0.001), and watts too having a significance of (P<0.01).

Figure 1 shows the difference in percentage for the experimental group, which clearly shows a major increase in aerobic parameters within the males and anaerobic parameters in the females.

Table 3: Pre-Post Readings in Males vs. Females

Variables	Description	Sum of Squares	Df	Mean square	F	Sig.	Post-Hoc Scheffe Test	
							Group	Sig.
Time to Exhaustion	Between groups	30.37	3	10.12	14.57	.000	1 & 2	**
	Within groups	22.22	32	.69			3 & 4	Non-Sig.
	Total	52.59	35					
VO2 (KG)	Between groups	708.24	3	236.08	42.44	.000	1 & 2	***
	Within groups	177.98	32	5.56			3 & 4	Non-Sig.
	Total	886.23	35					
RER	Between groups	.003	3	.00	.25	.854	1 & 2	Non-Sig.
	Within groups	.114	32	.00			3 & 4	Non-Sig.
	Total	.117	35					
HR MAX	Between groups	242.69	3	80.89	1.15	.342	1 & 2	Non-Sig.
	Within groups	2240.27	32	70.00			3 & 4	Non-Sig.
	Total	2482.97	35					
MET's	Between groups	52.098	3	17.36	31.07	.000	1 & 2	***
	Within groups	17.885	32	.55			3 & 4	Non-Sig.
	Total	69.98	35					
Watts	Between groups	90588.37	3	30196.1	27.55	.000	1 & 2	*
	Within groups	35068.37	32	1095.88			3 & 4	**
	Total	125656.7	35					
VE	Between groups	3267.13	3	1089.04	11.66	.000	1 & 2	Non-Sig.
	Within groups	2988.10	32	93.37			3 & 4	Non-Sig.
	Total	6255.24	35					
Average Power	Between groups	76513.87	3	25504.6	26.57	.000	1 & 2	Non-Sig.
	Within groups	30705.99	32	959.56			3 & 4	Non-Sig.
	Total	107219.8	35					
Peak Power	Between groups	4764.64	3	1588.21	1.27	.300	1 & 2	Non-Sig.
	Within groups	39907.96	32	1247.12			3 & 4	Non-Sig.
	Total	44672.60	35					
50 meter Dash (seconds)	Between groups	3.85	3	1.28	7.19	.001	1 & 2	Non-Sig.
	Within groups	5.71	32	.17			3 & 4	Non-Sig.
	Total	9.57	35					

Group 1 = Males Pre-Test
Group 2 = Males Post-Test
Group 3 = Females Pre-Test
Group 4 = Females Post-Test



* P < 0.05, ** P < 0.01, ***P < 0.001

Figure 1. Males vs Females compared in percentages for experimental group.

DISCUSSION

In this present study, statistical analysis revealed that time, VO2 max, METs and VE increased significantly in males, while average power, peak power, watts and velocity increased more significantly in females. i.e; Comparatively, aerobic capacity is increased in males while anaerobic performance is increased in females. The increased in aerobic capacity (in both males and females) may be primarily due to ashwagandhas effect on increasing RBC count and HB levels (Ziauddin et al 1996). The increase in RBC mass leads to increase in the blood capacity to transport oxygen to exercising muscles (Mcardle 1996) and in turn enhances the aerobic capacity, which increases performance.

The gender differences due to increments in aerobic capacity can be partially explained as generally, in comparison to males, females have a lower VO2 max (aerobic capacity) than males, which is primarily due to their physiological build up (Mcardle 1996). As the amount of blood the heart can pump partially determines VO2 max, men who are physically larger than women have a larger heart that pumps more blood (Mcardle 1996). This is also the case as men have larger lungs to take in more oxygen per-inhalation, compared to women/ females.

However, factors that attribute to changes or increments in VO2 max apart from gender are such as genetic potential, age, training status, exercise modes and body composition. Not only this component affects the maximal aerobic capacity of a person yet women possess more body fat, which is metabolically, is less active compared to muscles and take less of oxygen so partially explains the greater increase in aerobic capacity in males than females.

The improvement in anaerobic capacity can be attributed to the fact that Ashwagandha is known to possess the testosterone increasing effects, which was demonstrated in infertile males (Ahmad et al in 2010). Another study done Abdel-Magied et al in 2001, reported that Ashwagandha possess a direct spermatogenic influence on the seminiferous tubules of immature rats presumably by exerting a testosterone like effect, which will directly cause an increase in muscle growth and increase in strength.

It is also hypothesized that Ashwagandha acts as a potent boost towards the Luteinizing hormone, which is also known as lutropin, hormone which is produced by the anterior pituitary gland, thus increase in anaerobic capacity more in females can be attributed to the fact that Ashwagandha acts on the endocrine system to produce these anabolic effects in females, causing a direct increase in watts, average power and peak power. Therefore even though Ashwagandha is not an anabolic herb in itself, yet it possesses ingredients like steriodal lactones, which could have lead to increase in power and velocity in females.

CONCLUSION

In this present study, under the experimental conditions set up, we conclude that there are significant beneficial effects of Ashwagandha (*Withania Somnifera*) supplementation on gender differences. Thus it can be concluded from our study that responsiveness in male elite cyclist showed an increased effect on their aerobic capacity, while in female elite cyclist on their anaerobic capacity had increased effect upon the supplementation.

ACKOWLEDGEMENTS

We would like to acknowledge the role of the Central Council for Research in Ayurveda and Siddha (CCRAS) and Dabur India Ltd. in the subsidization, preparation, and standardization of the *Ashwagandha* capsules used in this research.

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Combined Effects Of A Circuit Training Programme And Honey Supplementation On White Blood Cells And Natural Killer Cells In Young Males

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Abstract

Besides physical activity, immune level can be enhanced and maintained through adequate nutritional intake. To date, little is known about combined effects of exercise and honey supplementation on white blood cells and natural killer cells in young males. This study investigated the effects of 6 weeks combined circuit training programme and honey supplementation on white blood cells and natural killer cells in young males. Forty male subjects (Age:19 to 29 years old) were divided into four groups, with ten subjects per group (n=10): sedentary without honey supplementation control (C), sedentary with honey supplementation (H), circuit training without honey supplementation (Ex), circuit training with honey supplementation (HEx) groups. Circuit training consisted of one hour/session, 3 times/week for six weeks. Types of activities prescribed in this circuit training programme were free weight dumbell triceps extension, rope skipping, free weight dumbell concentration curl, sit up, back extension, burpee, push up, split squat, hand and leg elastic band exercises. Subjects in H and HEx consumed 300 mL of honey drink containing 20 g of Tualang honey for 7 days/week. Blood samples were taken before and after experimental period for measuring white blood cells and natural killer cells to determine the level of immune functions.There were no significant changes in white blood cells in C, H, Ex and HEx groups. Greatest increment in NK cell were observed in HEx among the groups. Combination of circuit training and honey supplementation elicit greater effects on natural killer cells compared to circuit training or honey supplementation alone.

INTRODUCTION

Immune system has evolved to protect us from pathogens. Intracellular pathogens infect individual cells for example, viruses, whereas extracellular pathogens divide extracellularly within tissues or the body cavities, eg. bacteria. Leucocyte are central to all immune responses, and other cells in the tissue also participate by signaling to the lymphocytes and responding to the cytokines released by T cells and macrophages (Male *et al*, 2006).

Exercise causes many profound changes in parameters of immune function, the nature and magnitude of such changes depend on several factors including the type, intensity, and duration of exercise, fitness level or exercise history of the subject, environmental factors such as ambient temperature and the time course of measurement (Nieman and Pedersen, 2000).

Moderate exercise has been linked to a positive immune system response and a temporary boost in the production of macrophages, the cells that attack bacteria. It is believed that regular, consistent exercise can lead to substantial benefits in immune system (Quinn, 2008). During moderate exercise, immune cells circulate through the body more quickly and are better able to kill bacteria and viruses. After exercise ends, the immune system generally returns to normal within a few hours, but consistent, regular exercise seems to make these changes a bit more long-lasting (Quinn, 2008). Acute exercise, both endurance and resistance, could induce a marked increase in circulating leucocyte count (Petridou *et al.*, 2006). The cell surface expression of adhesion molecules makes an important contribution to such changes by altering patterns of leucocyte trafficking and redistribution (Petridou *et al.*, 2006).

Honey is a natural sweetener comprising vitamins, mineral, enzymes, and carbohydrates. It also contains natural antioxidant properties which can destroy biologically destructive chemical agents such as cancer, and protect against cellular damage and possibly prevent the development of chronic diseases. Honey also has antioxidant and antibacterial properties which can help to improve digestive system, so that one can stay healthy and fight disease (Tan, 2007). It was reported that honey may increase immune function, treat or prevent anemia, and can help to boost gastrointestinal ulcer healing (Neff, 2007).

To date, no studies have been carried out to investigate the effects of combined circuit training and honey on immune functions. Thus, the present study was proposed to investigate the effects of a circuit training programme and honey supplementation on blood white blood cells and natural killer (NK) cells in young males.

METHODS

Subjects

Forty young Malaysian male subjects with age ranging from 19 to 25 year old were recruited in this study. The inclusion criteria of the subjects were free from any health problems, and did not have the habit of taking honey as daily supplementation prior to the experiment. The subjects were assigned into four groups, with ten subjects per group (n=10): six weeks of sedentary without honey supplementation control (C), six weeks of sedentary with honey supplementation (H), six weeks of circuit training exercise without honey supplementation (Ex), six weeks of circuit training exercise with honey supplementation (HEx) groups. Each subject was given a detail explanation about the objectives, procedures, benefits, risks and possible discomforts experienced in this study. This study was approved by the Human Research and Ethical Committee Universiti Sains Malaysia. Subjects were reminded regarding their participation in this study as being voluntary and they were permitted to stop being a part of this study at any time during the course of the study period.

Honey supplementation

Tualang honey, a Malaysian local product was used in this study. Three hundred ml of honey drink which containing 20 g of Tualang honey was consumed by the subjects of honey supplementation alone group (H) and honey supplementation with exercise group (HEx) per day, seven days per week for six weeks. Subjects in HEx consumed 300 ml of honey drink 30 minutes before performing exercise. The honey drink was prepared by mixing 20g of honey with 300ml of plain water.

Blood taking and anthropometric measurement

Immediately before six weeks of experimental period, all the subjects were required to have blood sample taking, and anthropometric measurement sessions. Blood taking was carried out again after 6 weeks of experimental period. Both blood taking sessions were conducted in the morning at 8.30 a.m after a 10 hour fast of the subjects (drinking water was permitted). The blood was withdrawn by the laboratory technologist in the Exercise and Sport Science Laboratory. About 2 ml of blood were drawn from each subject from the antecubital vein in seated position. Blood taking for subjects in Ex and HEx were carried out 18-20 hours (8-10 am) after performing exercise.

Blood samples collected into EDTA tubes and were brought to the immune laboratory and processed on the same day of collection. An automated hematology analyser (Sysmex XS-800i) was used for analysis of white blood cell, whereas, analysis of natural killer (NK) cells was carried out by using a flow cytometer (BD FACS Cantor II, Becton Dickinson, USA).

After the blood taking, subjects' physical and physiological measurements such as body height, weight, and percentage body fat were carried out on the same day. The subject's body heights were measured by stadiometer (Seca 220. Germany), the body weight, and percentage body fat were measured by a digital bioelectric impedance analysis device (Kanada Scan, Japan).

Circuit training programme

The subjects in both the exercise without supplementation group (Ex) and honey supplementation with exercise group (HEx) were required to carry out circuit training sessions, one hour per session (5.30 p.m to 6.30 p.m), three times per week for six weeks.
The exercise sessions started with 10 minutes of warm-up and ended with 5 minutes of cooling down activities. Each circuit training programme consisted of two circuits. In each circuit, subjects performed 10 different exercises in 10 different stations, with one type of exercise per station, and each subject spent 30 seconds in one particular station. The work rest ratio was 1:2, where subjects exercised for 30 seconds for one activity, and rested for one minute before continued with the next activities. Resting time between circuits was five minutes. The activities that involved in circuit training were hand elastic bend exercise, leg elastic bend elastic, free-weight dumbbell triceps extension, rope skipping, free-weight dumbbell concentration curl, sit-up, back extension, burpee, push-up and split squat. The intensity of circuit training programme was estimated through the measurement of heart rates by a heart rate monitor (polar watch, S710, US) wore by subject throughout the circuit training programme.

Statistical analysis

Statistical software in the Statistical Package for Social Sciences (SPSS) Version 18.0 was used for the statistical analysis. Repeated measure ANOVA was performed to determine the significance of the difference between and within groups. Statistical significance was accepted at $p < 0.05$. All data are expressed as means ± standard deviation (SD).

RESULTS

Subjects' physical characteristics and physiological profile are tabulated in Table 1. Results of white blood cells are showed in Table 2. The results in pre-and post-tests showed that there were significant differences in white blood cells in Ex and HEx groups compared to respective C group respectively. After 6 weeks of experimental period, there were no statistically significant differences between pre- and post- tests in white blood cells in all C, H, Ex and HEx groups.

Table 1: Physical characteristics of all the subjects (Mean ± SD)

Parameters	Mean ± SD
Height (cm)	169.76±6.06
Weight (kg)	68.12±13.41
Body mass index (BMI) (kg/m²)	23.55±4.06
Percentage body fat (%)	18.88±5.99

For NK cells, results of all the groups at pre- and post- tests are shown in Figure 1. In pre-test, there were no significant differences in H,Ex and HEx compared to respective C group respectively. In post test, there were significant greater value of NK cells in Ex and HEx groups compared to respective honey (H) group respectively. After 6 weeks, no significant differences were observed between pre- and post-tests in NK cells in all groups. The greatest percentage difference between pre and post test in NK cell was observed in HEx group.

Table 2: White blood cells at pre- and post tests (Mean ± SD)

Groups	White Blood Cell (10^3/uL)			
	Pre test	Post test	Mean difference between pre and post test	Percent difference compared to pre-test (%)
Control (C)	5.84±1.68	6.16±0.99	0.32±1.33	+5.48
Honey (H)	6.31±1.04	6.34±0.87	0.03±1.07	+0.50
Exercise (Ex)	7.07±1.28+	7.28±1.42+,#	0.21±0.87	+2.98
Combined Honey and Exercise (HEx)	7.10±2.13+	7.63±1.33+,#	0.52±2.16	+7.38

+, significantly different from respective control group ($p<0.05$)
#, significantly different from respective honey group ($p<0.05$)

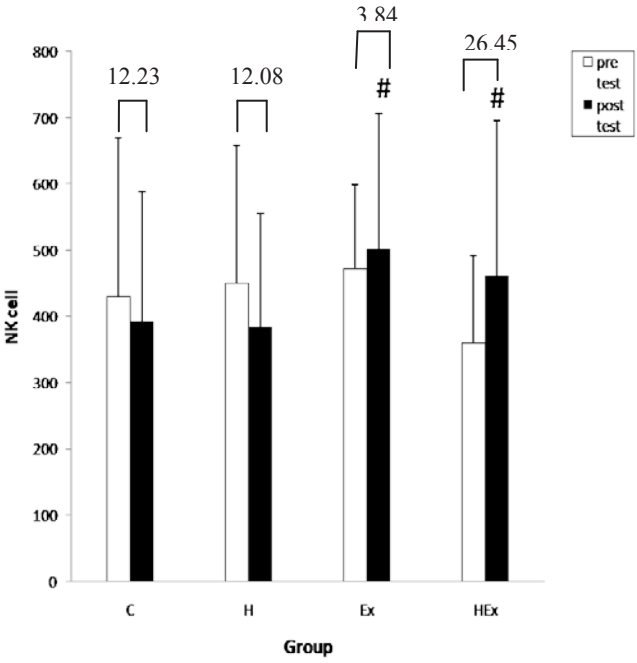

Figure 1 : Natural Killer (NK) cells count (cells/mm^3) at pre- and post tests (Mean ± SD)
#, significantly different from respective honey group ($p<0.05$)

DISCUSSION

The present study found that there were no significant changes in white blood cells in C, H, Ex, and HEx groups. These findings imply that H, Ex and HEx did not significantly affect white blood cells of the subjects.

In natural killer (NK) cells, there were no significant differences in baseline levels at pre test. After 6 weeks of experimental period, there were significant greater value of NK cells in Ex and HEx groups compared to respective honey (H) group, nevertheless, no significant differences were observed between pre and post test in all the groups. Regarding percentage increment, great percentage difference (+26.45%) between pre- and post test in NK cell was observed in HEx group, and this percentage increment was the greatest among the groups. This implies that HEx may elicit greater beneficial effects than Ex alone and H alone in increasing NK concentration, even though it was not statistically significant.The present findings reflect the immune status of the subjects where blood taking was carried out 18-20 hours after exercise in Ex and HEx. The exercise intensity in the present study was considered moderate based on the observation that the exercise heart rate of the subject ranged from 120 bpm to 140 bpm throughout the circuit training session, which presents 60% to 70% heart rate maximum.

The present study found that white blood cells which is also known as leukocytes were not significantly affected in C, H, Ex, and HEx. Similarly, Woods *et al* (1999) reported that six months of moderate aerobic exercise training had no effect on absolute numbers of total leukocytes. It was mentioned by Moynihan *et al* (1998) that the circulating numbers and functional capacities of leukocytes may be decreased by repeated bouts of intense, prolonged exercise. The reason is probably related to increased levels of stress hormones during exercise and entry into the circulation of less mature leukocytes from the bone marrow (Gleeson, 2005). Eventhough the intensity of exercise prescribed in the present study was considered moderate, increase in white blood cells was not observed.

In the present study, it was observed that NK cells elicited significant higher values in Ex and HEx groups compared to H in post test. Nevertheless, the percentage difference in NK cell was the highest in HEx among the groups. These findings imply that both Ex and HEx may have potential in increasing NK cells. However, the effect is greater in HEx group.

Regarding effects of exercise on NK cells and related immune parameters, as reported in a previous study that the amount of T-lymphocytes subsets, i.e. CD4, CD8, and NK markedly increased immediately after exercise, but lowered below the pre-exercised levels after 30 min recovery (Vider *et al*, 2000). Woods *et al* (1999) also showed that percentage of CD4 cells decreased and percentage of CD8 cells increased immediately after acute maximal exercise. Shepard & Shek (1999) reported that acute maximal exercise temporarily increases the number of circulating NK cells, but, following exercise, NK cell counts drop to less than one-half of normal levels for a couple of hours and normal resting values are usually restored within 24 hour. Shepard and Shek (1999) also mentioned that NK-cell cytolytic activity (per cell) falls after exercise, and, if the activity is both prolonged and strenuous, the decrease in NK cell counts and cytolytic activity may begin during the exercise session. Nemet *et al* (2004) showed that wrestling exercise led to a significant increase in the number of B cells, CD3, CD8, CD4 and natural killer cells. In a study comparing elite female rowers and controls, NK cell activity measured 1.6-fold higher in

the rowers (Nieman *et al*., 2000). Elevated NK cell activity has also been reported in runners and cyclists (Nieman *et al*., 1995; Tvede *et al*., 1991). In our present study, the findings reflect the chronic effects of honey supplementation and circuit training on NK cells, but not the acute effects such as a single session of honey supplementation and circuit training on NK cells.

It was hypothesized that when exercise and honey supplementation combined together in the present study, this combination may enhance immune function of the subjects greater than if exercise or honey supplementation is carried out alone. The present study found that when honey supplementation combined with circuit training, its effect on increasing NK cell was greater than circuit training alone and honey alone. This finding has supported our hypothesis. The precise mechanism for inducing these beneficial effects is unclear. However, it is speculated that during exercise, more blood is needed by ones' body, therefore more vital nutrients contained in honey have been absorbed into ones body during exercise consequently. These vital nutrients have enhanced immune functions of the subjects, reflected by the enhancement of NK cell counts. Nevertheless, further investigation with longer duration is needed to confirm the present results.

CONCLUSION

The present study found that the combination of circuit training programme with honey supplementation may have potential to elicit beneficial effects on natural killer cells (NK) compared to sedentary without supplementation in young male subjects. Thus, combination of a circuit training programme and honey supplementation can be proposed for formulating guidelines in planning exercise and nutritional promotion programmes for increasing immune functions in young males.

ACKOWLEDGEMENTS

Great appreciation to Madam. Malisa Yoong bt Abdullah for her laboratory assistance. I would also like to acknowledge all the staffs of the Exercise and Sport Science Program, Sport Science Unit, Universiti Sains Malaysia, Madam.Mazra bt Othman, Mr. Hafizi for their assistance throughout my study.

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ISBN 978-967-0486-32-1