THE EFFECTS OF PHYSICAL ACTIVITY ACROSS CURRICULUM (PAAC) ON ACADEMIC ACHIEVEMENT, BODY MASS INDEX AND COGNITIVE PERFORMANCE AMONG 10 YEARS OLD STUDENTS

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By

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ABSTRAK

Pengenalan : Aktiviti fizikal melalui kurikulum (PAAC) mampu memberi faedah kepada pelajar. Kajian ini dilakukan untuk mengkaji kesan PAAC terhadap pencapaian akademik, indeks jisim badan dan pencapain kognitif di kalangan pelajar sekolah.

Objektif : Mengkaji kesan aktiviti fizikal melalui kurikulum (PAAC) terhadap pencapaian matematik, indeks jisim badan dan pencapaian kognitif (ingatan jangka pendek) di kalangan pelajar berumur 10 tahun.

Kaedah : Seramai lima puluh enam pelajar berumur 10 tahun telah dipilih dan dibahagikan kepada dua kumpulan dengan jumlah dua puluh lapan setiap kumpulan (n=28): kumpulan aktiviti fizikal melalui kurikulum (PAAC) dan kumpulan bukan aktiviti fizikal melalui kurikulum (non PAAC). PAAC dijalankan selama 60 minit setiap minggu, 2 sesi dan 30 minutes setiap sesi sepanjang 7 minggu. Peserta dalam kumpulan PAAC bermain aktiviti pilihan seperti melompat, berlari dan berjalan. Peserta kumpulan bukan PAAC pula diajar menggunakan kaedah pembelajaran tradisional.

Keputusan : Pada pasca ujian, tiada perubahan secara signifikan ($p>0.05$) dalam pencapaian akademik (markah ujian Matematik) terhadap kumpulan PAAC dan bukan PAAC. Markah ujian Matematik meningkat ketika pasca ujian berbanding pra ujian dalam kedua-dua kumpulan. Peningkatan peratusan markah ujian Matematik dalam kumpulan PAAC adalah lebih tinggi (+27.60%) berbanding kumpulan bukan PAAC

(+15.42%). Tiada perubahan secara signifikan ($p>0.05$) dalam indeks jisim badan dalam kumpulan PAAC. Perubahan peratusan dalam kumpulan PAAC adalah -2.56% manakala kumpulan bukan PAAC (+0.86%). Manakala tiada perubahan secara signifikan dalam pencapaian kognitif (ujian DS). Namun peningkatan peratusan ujian DS dalam kumpulan PAAC adalah paling tinggi (+43.39%) berbanding kumpulan bukan PAAC (+19.57%).

Kesimpulan : Aktiviti fizikal melalui kurikulum (PAAC) mempunyai potensi untuk dicadangkan sebagai panduan dalam merancang program senaman untuk meningkatkan pencapaian akademik, indeks jisim badan dan pencapaian kognitif di kalangan peserta berumur 10 tahun.

THE EFFECT OF PHYSICAL ACTIVITY ACROSS CURRICULUM (PAAC) ON ACADEMIC ACHIEVEMENT, BODY MASS INDEX AND COGNITIVE PERFORMANCE AMONG 10 YEARS OLD STUDENTS

ABSTRACT

Introduction: Physical Activity Across Curriculum (PAAC) can give beneficial effect to the students. This study was designed to examine the effect of PAAC on academic achievement, body mass index and cognitive performance among school students.

Objective: To determine whether Physical Activity Across Curriculum (PAAC) affect academic achievement (Mathematic), body mass index, and cognitive performance (short-term memory) among 10 years old students.

Methods: Fifty six primary school students aged 10 years old were recruited and being assigned into two groups, with twenty eight participants per group (n=28): physical activity across curriculum (PAAC) and non-physical activity across curriculum (non PAAC) groups. PAAC were carried out 60 minutes per week, 2 sessions, and 30 minutes per session for 7 weeks. Subjects who were involved in physical activity played selected activities such as jumping, running and walking. The non PAAC group were taught via traditional classroom method.

Results: At post test, there was no significant ($p>0.05$) difference in academic achievement (Mathematic test score) in PAAC and non PAAC. Mathematic test score increased in post test compared to pre test in PAAC and NON PAAC groups. The percent increase of mathematic test score in PAAC group was higher (+27.60%) than

non PAAC (+15.42%). There also was no significant ($p>0.05$) difference in BMI in PAAC group. The percentage change in PAAC group was -2.56%. The percent increase of BMI in non PAAC group was +0.86%. There was no significant changes in cognitive performance (digit span test). However, the percent increase of digit span test in PAAC group was higher (+43.39%) than non PAAC (+19.57%).

Conclusion: Physical activity across curriculum (PAAC) has potential to be proposed for formulating guidelines in planning exercise promotion programmes for increasing academic achivement, body mass index and cognitive performance in participants aged 10 years old.

CHAPTER 1

INTRODUCTION

1.0 Background of the study

Academic achievement has always been an important aspect among school students life. Inherently, students spend a lot of times studying, doing homework and attending extra tuition (Singh *et al.*, 2012). In Malaysia, school students have to sit three national level examinations at the ages of 12, 15 and 17 years old (Hashim, Freddy and Rosmatunisah, 2011). These examination are considered so important that most school students struggle to get good academic achievement.

In a survey conducted among 500 parents by The Straits Times and a research company Nexus Link, they found that seven in 10 parents enrolled their children in some extra classes. Almost 70 per cent said attending extra classes was to improve grades, but 52 per cent said it was to help their children to socialize with others (Straits Times, 2017). This show that most students spend their time attending extra class rather than spending time for exercise or physical activity.

Most of the students tend to limit their time for physical activity to focus more in academic preparation. A previous study show that students who are involved higher in physical activity tend to have poorer academic results (Hashim, Golok and Ali, 2011). Kementerian Pendidikan Malaysia has standardize total hours of Pendidikan Jasmani and Pendidikan Kesihatan in every school. Students are allocated 60 minutes for ‘Pendidikan Jasmani’ and 30 minutes for ‘Pendidikan Kesihatan’ in school every week (Kementerian Pendidikan, 2017), but these classes tend to be used for academic activities especially among year 6 students.

Approximately 98% of children are enrolled in school in the U.S., and this help the children to access and could enable repeated exposure to health promotion interventions (Donnelly and Lambourne, 2011). The prevalence of physical activity among Asian school-age children and adolescent has been reported by Muller at el. (2013). The researchers have reviewed 30 articles published between 2000 and 2011 on physical activity prevalence of school-age children and adolescents which included East Asia, Southeast Asia, South Asia and West Asia. In Malaysia, the study was done by Zalilah *et al*. (2006) among 301 males and 317 females subjects using the instrument of physical activity 3-day activity record and the result shows that the time spent by the children and adolescents in moderate to vigorous physical activity was 2.8 minutes per day including housework and other movements (Zalilah *et al*., 2006). The pressure from administration, teachers and parents to increase in academic achievement give more stress to the students and lead to physical inactivity among students (Maldonado, 2015).

Physical inactivity can lead to many disadvantages among school children. Although many studies show the negative result of physical inactivity, they still ignore it and focus only on the academic achievement (Donnelly and Lambourne, 2011). Globally, physical inactivity is estimated to cause 10% to 16% of cases in chronic diseases such as breast cancer, colon, and rectal cancers has rapidly increased in recent decades (WHO 2004). In addition, an elevated body mass index (BMI) among children and adolescents causes greater risk for cardiovascular disease (CVD) as adults (Haque 2008; USDHHS 2008). Girls have been found to be less active than boys, older children and adolescents less active than younger children, and black girls less active than white girls (Ogden *et al*. 2006).

Donnelly and colleagues completed a 3-year cluster randomized, controlled trial of 24 elementary schools among grade 2 and 3 students to compare changes in fitness and fatness with changes in academic achievement in schools that received PAAC. PAAC provide 90min/week of moderate to vigorous physically active academic lessons (3.0 to 6.0 METS, ~10 min each) delivered intermittently throughout the school day. The results from that study show that schools with greater than 75 min of PAAC/week showed significantly less increase in BMI at year 3 compared to schools with lower than 75 min of PAAC/ week (Donnelly & Lambourne 2011).

Many of adolescent's physical activity is not intense enough to achieve health benefits and many of them do not meet the recommended guidelines (Tremblay *et al*., 2002). Further, these already insufficient amounts of physical activity are in declining pattern in physical education class time and organized sport (Dollman *et al.*, 2005). Therefore, it would be ideal for adolescents to participate in physical activity from within the school setting such as physical education and extra-curricular physical activity program which in many instances, the participation is compulsory (Trost, 2007). The development of exercise habit during childhood and adolescence could encourage the habit of exercise later in life (Marsh & Peart, 1988). However, sustaining exercise habits for long duration is very hard to accomplish and many people often quit it easily (Nigg *et al*., 2008). In this regards, types of physical activities that provide enjoyment, such as aerobic dance, may be beneficial for long term benefits (Deci & Ryan, 2011; Piipari *et al*., 2012). Besides, this type of activity, which involves complex whole body coordination has been found to provide positive cognitive benefits (Best *et al*., 2010). Furthermore, physical activity affects the brain cognitive functions such as attention and working memory, through the increase of neurotic

activity in the brain. Hence, it could be a healthy and possible natural alternative for students learning improvement (Tomporowski *et al*., 2008).

Cognitive performance is an essential indicator of abilities and skills from the psychological functional ranges such as perception, attention (concentration), learning and retention, thinking and intelligence (Newell *et al*., 2003; Tomporowski, 2008). In addition, cognitive performance is a core mental ability that enables people to learn effectively. It support the ability to read, remember, comprehend, interpret and analyse information. It is essential for students' academic performance because it strengthen higher thinking for the acquisition of knowledge. When students' cognitive skills are strengthened, their overall learning ability will improve (Olivia, 2012).

Memory is a type of cognitive function that is involved in learning and is often considered as the mental workspace where essential information is retained in a very active state with a variety of other cognitive processes (Pesce *et al*., 2009). It includes the processes of encoding, storing, and manipulating this information. Memory enables a student to retain information for a short time when they are using or processing it (Baddeley *et al*., 1999). Inability to retain information long enough or to handle it correctly impacts learning ability. Therefore, efficient memory is generally considered essential for students to cope with scholastic and daily life demnads (Olivia, 2010).

Memory is central to cognitive improvement as it is considered to be connected to age-related increase in storage capability and better use of available storage capacity (Pesce *et al*., 2009). Research has documented that difficulty in working memory may cause learning problems which consequently lead to poor academic performance. Moreover, students who lack working memory and function of memory storage will

face problems in learning, which consequently lead to behavioural complications (Passolunghi & Siegel, 2001; Aronen *et al*., 2005).

It is known that there are many benefits of physical activity for multiple cognitive domains such as remembering, understanding, applying, analysing, evaluating and creating which includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. Physical activity also have demonstrated improvements in both cognition and concentration which can lead to positive academic outcomes (Chomitz *et al.*, 2009). Movement of skeletal muscle during physical activity can help to increase blood flow in the brain, increase cardiac output, vasodilation that can increase blood flow to the tissue and improve brain function in the brain that can lead to increase the intelligence which relates to academic achievement. So, physical activity can improve intelligence due to increase blood flow to the brain (Morgan, Corrigan and Baune, 2015).

The time spent at school during a day for physical activity among adolescent is affected by the school environment. Students can do physical activity in school environment which include unstructured recess, physical education, and physical activities before, during, and after class time. Providing opportunities to engage in physical activities that embed academic may be desirable (Kibbe *et al.*, 2011). One of such initiative is Physical Activity Across curriculum program (PAAC). PAAC generally takes the form of short breaks from academic instruction where some type of physical activity occurs (Donnelly *et al.*, 2011). Lessons were usually delivered in the classroom, but were also delivered in alternate school sites such as hallways and outdoors. PAAC lessons were used in a variety of academic areas including math,

language arts, geography, history, spelling, science, and health. PAAC promoted 90min/week of moderate to vigorous physically active academic lessons (3.0 to 6.0 METS, ~10 min each) delivered intermittently throughout the school day. Lessons were usually delivered in the classroom, but were also delivered in alternate school sites such as hallways and outdoors. PAAC lessons were used in a variety of academic areas including math, language arts, geography, history, spelling, science, and health (Donnelly *et al.*, 2009a).

Chomitz (2008) demonstrated a significant positive relationship between fitness and academic achievement which was assessed as a passing score on the Massachusetts Comprehensive Assessment System (MCAS) achievement test in Mathematics and in English among urban public school children. Other than that, another previous research has indicated that acute bouts of moderately-intense aerobic exercise (i.e. walking) have improved the cognitive control of attention and academic performance in pre-adolescent children age 9 to 10 years old after contributed with moderate acute exercise e (Hillman *et al.*, 2009). Academic performance among preadolescent children were assess using Wide Range Achievement Test 3rd edition (WRAT3; Wide Range, Inc., Wilmington, DE, USA) in the content areas of reading (i.e. the number of words correctly pronounced aloud), spelling (i.e. the number of words correctly spelled), and arithmetic (i.e. the number of mathematical problems correctly solved). It is shown that academic achievement increased but there were low effect on spelling and arithmetic (Hillman *et al.*, 2009).

The purpose of this study was to assess whether Physical Activity across Curriculum has an effect on academic achievement, body mass index and cognitive performance in students. The presence of a physically active lifestyle has received much support due to its physiological and mental benefits. The establishment of such a lifestyle should begin at an early age. Physical activity programme within the school system could perpetuate a healthier future.

1.1 Objective of the Study

General objective

The main objective of this study is to determine whether Physical Activity Across Curriculum (PAAC) affect academic achievement, body mass index, and cognitive performance in primary school students.

Specific objectives

1. To determine the effects of Physical Activity Across Curriculum (PAAC) on mathematic achievement among 10 years old students.
2. To determine the effects of Physical Activity Across Curriculum (PAAC) on body mass index among 10 years old students.
3. To determine the effects of Physical Activity Across Curriculum (PAAC) on cognitive performance (memory) among 10 years old students.

1.2 Significance of the Study

If the present study finds that physical activity across curriculum approach can increase academic achievement, physical health and cognitive performance, this initiative can be proposed to the teachers to increase in academic performance and physical health among students.

1.3 Hypothesis

Ho: There are no significant differences in academic achievement (mathematic) in students with PAAC lessons compared to students without PAAC.

H_A: There are significant differences in academic achievement (mathematic) in students with PAAC lessons compared to students without PAAC.

Ho: There are no significant differences in body mass index in students with PAAC lessons compared to students without PAAC.

HA: There are significant differences in body mass index in students with PAAC lessons compared to students without PAAC.

Ho: There are no significant differences in cognitive performance (memory) in students with PAAC lessons compared to students without PAAC.

HA: There are significant differences in cognitive performance (memory) in students with PAAC lessons compared to students without PAAC

1.4 Operational Definitions

Physical Activity Across Curriculum: Short breaks from academic instruction when some types of physical activity occurs.

Academic achievement: Performance in Mathematic test score is used to operationalized the academic achievement.

Body mass index: A weight-to-height ratio, calculated by dividing one's weight in kilograms by the square of one's height in meters and used as an indicator of obesity and underweight.

Anthropometric measurements: Measurements of body height and body weight.

Cognitive function (short term memory): A memory test using Digit Span Test to measure the ability of the subjects in memorizing the digit.

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of physical activity and exercise

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure such as walking, gardening and hiking. Exercise is part of physical activity that is planned, structured, repetitive, and purposive such as weight training, running, or an aerobics class in the sense to improve or maintain one or more components of physical fitness (Rahl, 2010). Both physical activity and exercise are related to each other as it refer to the voluntary movements and involve any bodily movement produced by skeletal muscles that expends energy, burn calories and reduce risk of developing diseases (Garber *et al.*, 2011).

Physical activity and exercise vary in intensity, type, duration and frequency. Intensity refers to the magnitude of the effort that required performing a physical task. According to American College of Sport Medicine (ACSM), example of moderate-intensity physical activity are walking at a moderate or brisk pace of 3 to 4.5 miles per hour on a level surface inside or outside, such as walking to class, work, or the store, walking for pleasure, walking with the dog or walking as a break from works and race walking which is less than 5 miles per hour. On the other hand, example of vigorous-intensity physical activity includes race walking and aerobic walking with 5 miles per hour or faster, jogging or running, walking and climbing briskly up a hill, backpacking mountain climbing, rock climbing, bicycling more than 10 miles per hour using vigorous effort.

Metabolic Equivalents (METs) are commonly used to express the intensity of physical activities. MET is the ratio of a person's working metabolic rate relative to their resting metabolic rate. One MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1kcal/kg/hour. Compared to sitting quietly, a person's caloric consumption is three to six times higher when being moderately active (3-6 METs) and more than six times higher when being vigorously active (>6 METs) (WHO, 2017).

2.2 Physical Activity Recommendation

American College of Sport Medicine (ACSM) guidelines for physical activity have been updated several times. The 2007 guidelines were supported by American Heart Association (AHA) to clarify the types and amount of physical activity can improve and maintain health. American College of Sports Medicine (ACSM) recommended that people who exercise three days per week or more, for a duration of 20 to 60 minutes per session, with an intensity of 65% to 90% of maximal heart rate, could maintain or develop their fitness level. Adults aged 18-65 years are recommend exercising 30 minutes of moderate-intensity daily physical activity for five days a week. Moderate-intensity aerobic activity, such as brisk walk which can accelerates the heart rate, can be accumulated toward the 30-minutes minimum by performing 10 minutes and above. In addition, at least twice each week adults will benefit by performing activities using the major muscles of the body that maintain or increase muscular strength and endurance (ACSM, 2007).

For children and adolescents, they should accumulate a minimum of 60 minutes or one hour of physical activity daily as part of transportation, physical education, sport, free play and planned exercise. The activities should be a combination of moderate and vigorous intensity. The ACSM recommends a combination of moderate

and vigorous intensity physical activity because children perform physical activity for enjoyment more than for health or exercise benefits (Rahl, 2010). Muscle-strengthening activities (such as gymnastics) and bone-strengthening activities (such as running or skipping rope) are also recommended on at least three days a week for example walking. For good health, 10,000 steps a day is recommended – this is about 5 miles (8km), depending on stride length, and is the equivalent of walking briskly for about 90 minutes. Brisk walking is an example of moderate-intensity activity; race walking becomes vigorous activity (ACSM, 2007). Department of Health recommended that children should participate in physical activity at least twice per week with moderate intensity to improve and maintain muscular strength, flexibilty and bone health (Department of Health, 2004).

Physical Activity Across Curicculum (PAAC), generally takes the form of short breaks from academic instruction where some type of physical activity occurs (Donnelly *et al.*, 2011). Lessons were usually delivered in the classroom, but were also delivered in alternate school sites such as hallways and outdoors. PAAC lessons were used in a variety of academic areas including math, language arts, geography, history, spelling, science, and health. Based on U.S. Department of Health and Human Services. (2000), the sixty minutes per week is chosen as the target since children are receiving 60 min of physical education per week and combine with PAAC lessons and this would total 120 min of PA per week which is closely consistent with recommendations from Healthy People 2010. Physical activity using PAAC has a number of potential advantages. The levels of physical activity in the elementary school increase in a large population of children. PAAC lesson change the classroom environment which children are not required to make an overt choice to be more physically active, but do so as part of the academic curriculum (Donnelly *et al.*, 2013).

A study by Kimball, (2009) showed no statistically significant improvements were observed between the exercise group and the control group in attention and memory after 4 month aerobic exercise (running games, ball games and jump rope) among overweight children 8 to 11 years old. Another study, Barbeau *et al*. (2007) studied the effect of 10 months of moderate to vigorous aerobic exercise (50 min/session/day) among girl students. Their results showed that higher attendance was associated with higher decreases in Body Mass Index (BMI) and total body fat.

2.3 Prevalence of Physical Activity

Global

The trend in physical activity is declining in all age groups. This decline is found steeper in the transition age from children to adolescents (Craggs *et al*., 2011). Lasheras *et al*. (2001) reported that among Spanish adolescent, only 30% of them are in active category and between boys and girls, boys are about 2.6 time more physically active than girls. The findings by Aarnio *et al*. (2002) indicated that the proportion of 16 years old Finns boys who are engaged in physical activity with a frequency of four times per week or more is only 33.5% and 25% among girls.

Indeed, it has been consistently shown that the level of physical activity is only low to moderate among adolescents and girls have much lower level of physical activity compared to boys. This exposes them to increasing threat of diseases due to their lesser participation in physical activity compared with the boys. Moreover, several studies have found evidence that the rate of drop out in physical activity among girls is higher compared with the boys (Vescio *et al*., 2005; Wang & Liu, 2007). But most of the studies have found the negative effects of physical inactivity.

Physical inactivity is estimated to cause 10% to 16% of cases in chronic diseases such as breast cancer, colon, and rectal cancers which has rapidly increased in recent decades (WHO 2004). In addition, an elevated body mass index (BMI) among children and adolescents causes greater risk for cardiovascular disease (CVD) as adults (Haque 2008; USDHHS 2008). Girls have been found to be less active than boys, older children and adolescents less active than younger children, and black girls less active than white girls (Ogden *et al*. 2006).

Asian

Studies conducted among Malaysian children and adolescents indicated low and moderate levels of exercise. For instance, Dan *et al.,* 2007 found that a majority of adolescents in their study have low (35%) and moderate (62%) levels of PA. Given the high level of physical inactivity among children and adolescents, a growing number of researchers believe it is necessary to further investigate factors that could potentially enhance adolescent involvement in PA (Sallis *et al*., 1999; Sallis *et al*., 2000). Rapid socio-economic development is associated with changes in the lifestyle of the community especially those from the urban areas, such as Kuala Lumpur. The changes include physical activities and food consumption pattrens (Moy *et al*., 2004).

The prevalence of physical activity among Asian school-age children and adolescent has been reported by Muller at el. (2013). The researchers have reviewed 30 articles published between 2000 and 2011 on physical activity prevalence of school-age children and adolescents which included East Asia, Southeast Asia, South Asia and West Asia. In Malaysia, the study was done by Zalilah *et al*. (2006) among 301 males and 317 females subjects using the instrument of physical activity 3-day activity record. Their results showsed that the time spent by the children and adolescents in

moderate to vigorous physical activity was 2.8 minutes per day including housework and other movements (Zalilah *et al*., 2006).

The highest level of recommendation for physical activity by World Health Organisation (2010) is at least 60 minutes of moderate physical activity every day. Nearly all data indicated that the majority of Asian children did not meet the guidelines for PA. Less than 50% of the samples reviewed met the minimum PA recommendations of 30 minutes, 3 days per week. Compared with other parts of the world, Asian school-age youth show low PA levels (Muller *et al*, 2013).

In T aiwan, although 80% of adolescents reported enganging in some physical activity, only 28.4% of the sample met recommended guidelines. Rural adolescents and girls in the 15 to 18 age range being the least active compared to boys and urban adolescents (Chen *et al*., 2007). In Korea, physical inactivity is only now being considered a cucial factor in the health of adolescents (Kim, 2007). According to Haskell *et al*. (2007), large proportions of the population in Japan are insufficiently physically active. According to pedometer measurements in the Japan National Health and Nutrition Survey 2005, only 21.3% o Japanese walk more than 10,000 steps a day (Inoue *et al*., 2009). This information shows that physical activity decreases steadily during adolescent, highlights the need for solutions to the problem of sedentary living (Kim, 2007).

2.4 Factors promoting physical activity and exercise

There are many factors that can affect involvement of students in physical activity such as social influence, school environment, peer, motivation, encouragement from teachers and facilities. The important factor affecting physical activity participation on the individual level is social influence. People who have active social influences tend to be more active themselves. For children, the main source of influence is their parents and adolescents focus almost entirely on their peers. Adolescents tend to exercise if they identify with a peer group that values, supports, and participates in physical activity (Rahl, 2010). Social environment also exert powerful influence of people behaviour especially for both children and adolescents (Bauman *et al.*, 2012).

Physiological, psychological, sociocultural, and ecological factors also influence participation of children in physical activity. Physiological factor include age, gender, and ethnicity determinants of physical activity among children and adolescents (Hudson 2008; Sallis 2000). Specifically, girls have been found to be less active than boys, older children and adolescents less active than younger children, and black girls less active than white girls (Ogden 2006). Psychological determinants of physical activity include confidence in one's ability to engage in exercise, perception of physical or sport competence (Sallis 2000) and enjoyment of physical activity (Dishman 2005).

Psychosocial factors, self-efficacy (confidence in the ability to be physically active in specific situations) was a consistent positive correlate and determinant of physical activity in children and adolescents. Perceived behavioural control (general

perceptions of ability to be physically active) is a determinant in adolescents, but evidence is inconclusive in children (Bauman *et al.*, 2012). The health-belief model (Rosenstock 1966) explained that an individual's behaviours are affected by perceived susceptibility of developing health problems, perceived impact of health problems on one's quality of life, and the belief that changing behaviour will be beneficial in avoiding the health problem (Dobbins *et al.*, 2013).

There are also so many aspects in the environment that influence physical activity in adolescence. These include environments such as home, school, neighbourhood, city and also country (Ferreira *et al*., 2007). Among these environments, school is the only place where the adolescents spend at least one third of their day (Taylor *et al*., 2000; Hylok, 2011). Therefore, it can be an important environment for the delivery of physical activity (Kim *et al.*, 2007). Indeed, it has been consistently suggested that health promoting "active" school models can address childhood health concerns (Naylor *et al*., 2006; Verstraete *et al*., 2007).

Evidence shows that school-based exercise programmes may be effective for increasing physical activity behaviours (Stone *et al*., 1998). Physical activity among high school students has also been shown to bring about significant health improvement in adolescents, especially females (Fardy *et al*., 1996). Furthermore, students who engaged in extracurricular sports generally interact more with their peers. They have greater educational motivation and have greater level of satisfaction with their educational experience (Eccles & Barber, 1999). Therefore, schools should encourage students and provide opportunities to learn and perform physical activities, especially those that can create feeling of enjoyment in students. Moreover, schools should educate and demonstrate to them the benefits of physical activity towards the

improvement and preservation of life span through exercise (Fletcher *et al.*, 1996). Physical activity can be delivered in the schools through school based programmes such as during recess, physical education lessons, classroom-based physical activity, physical activity clubs, and interscholastic sports (Koplan *et al*., 2005).

More importantly, to encourage school students to exercise and participate in physical activities within the school time, it would be more desirable for the schools to provide structured or unstructured exercise for their students (U.S. Department of Health and Human Services, 2010).

2.5 Benefits of physical activity and exercise

Physical activity and exercise can help to improve the ability to perform everyday activities. Physical activity has potential benefits for physical health, preventing poor mental health and encouraging positive mental wellbeing. It gives many benefits to many parts of the body such as skeletal muscle, heart, bone, blood, brain and immune system (Floor and Kingdom, 2011). The main body systems that play important roles to maintain the body functions during physical movement includes skeletal system, muscular system, respiratory system, cardiovascular system and nervous system. The skeletal system stores minerals and important to support and protect the body and is our framework for movement.

The muscular system is for facilitating movement, maintaining posture and producing heat. In the cardiovascular system, the heart pumps blood around the body so the blood can transport oxygen, carbon dioxide, nutrients and waste. In the respiratory system, oxygen is taken from the air and supplied to the blood, and carbon dioxide is removed. Nervous system is more complicated because it involves brain, spinal cord, nerves and sensory organs. The main functions of nervous system are

control voluntary movement, memory and learning, cognitive function and maintain homeostasis in the body (Morgan *et al*., 2015).

The increase of oxygen uptake can give benefit to all parts of the body especially muscles and brain. The sufficient blood flow in the muscle can help in reduce fatigue and maintaining the physical movement (Ainsworth and Macera, 2012). While the oxygen-rich blood reaches the brain through internal carotid arteries and vertebral arteries which supply oxygen-bearing blood to the front of the brain. Studies indicated that regular physical activity can maintain a clear mind, improve mental processing (Asztalos *et al.*, 2012), and reduce the rate of decline in cognitive functions associated with aging (Tabbarah *et al.*, 2002). All these benefits are related to the oxygen delivery to the brain during physical movements. In addition, favourable mental changes with exercise have been linked to brain structural changes and increased blood flow in capillaries in areas of the brain associated with memory and learning ability (Ainsworth and Macera, 2012).

People achieve about 50% of their adult weight, more than 20% of adult height, and 50% of their adult skeletal mass during adolescence (WHO, 2000). However, the rate of growth and maturation during adolescence are different in males and females. Females start their puberty and increase fat mass earlier. On the other hand, males experience acceleration of peak height, incerase of fat-free mass and increase in shoulder width earlier (Vizmanos & Marti-Henneberg, 2000). This affects body shape and further changes in the self-concept especially among females (Rathus, 2013).

Physical activity is an essential activity during the stage of adolescence. It contributes to the development of a normal skeletal growth and weight bearing necessary for adolescents to attain and maintain their suitable bone mass (Lasheras *et al*., 2001), and body weight by increasing energy expenditure (Woods *et al*., 2010).

Tomporowski *et al*. (2008) and U.S Department of Health and Human Services, (2008), indicated that children and adolescents who have regular physical activity, experience greater improvement in their body and mental health. In addition, they have reduced probability of diseases in the future compared with inactive individuals.

Participation in regular physical activity has also been found to decrease the rule-breaking behaviours and improving behaviour in the classroom. Furthermore, engagement in regular physical activity and various sports can play an essential role in improving the social life and social skills among students (Hallal *et al*., 2006; Woods *et al*., 2010).

Studies have also indicated that starting physical activity earlier and having fitness during adolescence are important determinants of adult fitness at the population level. Furthermore, children and adolescents with low fitness are more likely to have unfavorable obesity. Therefore, physical activity programmes can help them to improve and maintain their fitness (Dwyer *et al*., 2009).

2.6 Physical activity and cognitive function

Cognitive functions can be defined as cerebral activities which lead to knowledge such as reasoning, memory, attention, and language. Cognitive abilities are brain-based skills that need to carry out tasks from the simplest to the most complex. There is a strong belief that regular participation in physical activity is linked to enhancement of brain function and cognition (Hillman *et al.*, 2008), thereby positively influencing academic performance (Singh *et al.*, 2012).

Physical activity plays a vital role in improving cognitive and academic performance (Ploughman, 2008). Studies have reported that cerebellum activation, besides enhancing motor functions (Trudeau & Shephard, 2010), influences neurobehavioral system such as working memory (Sibley & Etnier, 2003). In addition,

many scientific evidence have indicated the importance of the front lobes, particularly the prefrontal areas, in the mediation of cognitive ability such as motor coordination and executive control (Trudeau & Shephard, 2010).

Physical activities involve physical movement which is increase in cardiac output, vasodilation that can increase blood flow to the tissue and the brain and improve brain function. So, physical activity can improve intelligence due to increase blood flow to the brain (Morgan, Corrigan and Baune, 2015). A previous study by Sibley and Etnier (2003), among school-age children, 4 to 18 years students, showed a positive association between physical activity and cognitive function including perceptual skills, intelligence quotient, academic achievement, verbal tests, mathematics tests, developmental level, and academic readiness.

A study with a randomized controlled trial (Davis *et al*., 2007) with highly controlled exercise intervention and a standardized achievement test indicated that physical activity interventions may have selective effects on children's cognition. Aerobic exercise training improved executive function in overweight children between the ages of 7 and 11 years. Scores on the Planning scale of the Cognitive Assessment System (CAS) were significantly higher for the children who performed 40 min of aerobic exercise 5 times per week compared to a control group (Davis *et al*., 2007).

In another study by Coe (2006), academic achievement was assessed from 4 core academic courses (math, science, English, world studies) and a standardized test among the 214 of sixth grade students to physical education either during their first or second semester. Physical activity outside of school was assessed by 3-day recall. No impact of physical activity on standardized test scores was observed. However,

students with higher levels of vigorous physical activity outside of school had significantly higher grades than those who reported no vigorous physical activity.

The physical activity and learning relationship is connected into the circuity of brain. Sedentary lifestyles create a health tension to this circuit (Ratey & Hagerman, 2008) and consequently affect learning and memory. Based on previous study, student's mental function and cognitive development can be improved by physical activity. Physical movement impacts the brain to improve cognitive processes by increase blood circulation to carry out oxygen, stimulates production of neurotransmitters and nerve growth factor that enhance mood improvement and generates new cells (neurogenesis) in the brain (Tomporowski *et al*., 2008).

Cognitive performance is an essential indicator of abilities and skills from the psychological functional ranges such as perception, attention (concentration), learning and retention, thinking and intelligence (Newell *et al*., 2003; Tomporowski *et al*., 2008). In addition, cognitive performance is a core mental ability that enables people to learn effectively. It support the ability to read, remember, comprehend, interpret and analyse information. It is essential for students' academic performance because it strengthen higher thinking for the acquisition of knowledge. When students' cognitive skills are strengthened, their overall learning ability will improve (Olivia, 2012).

Memory is a type of cognitive function that is involved in learning and is often considered as the mental workspace where essential information is retained in a very active state with a variety of other cognitive processes (Pesce *et al*., 2009). It includes the processes of encoding, storing, and manipulating this information. Memory enables a student to retain information for a short time when they are using or processing it (Baddeley *et al*., 1999). Inability to retain information long enough or to

handle it correctly impacts learning ability. Therefore, efficient memory is generally considered essential for students to cope with scholastic and daily life demands (Olivia, 2010).

Research has documented that difficulty in working memory affected by low physical activity may cause learning problems which consequently lead to poor academic performance. Moreover, students who lack working memory and function of memory storage will face problems in learning, which consequently lead to behavioural complications (Passolunghi & Siegel, 2001; Aronen *et al*., 2005). Besides, students learn by processing information, filtering out the unintended information, and store only the intended information into short-term memory. The information will then be encoded and stored in long term memory. When the information is retrieved from the long term memory, it will again be stored into the short-term memory (Gazzaniga & Heatherton, 2003).

2.7 Physical Activity Across Curriculum (PAAC)

Physical activity across curriculum (PAAC) generally takes the form of short breaks from academic instruction where some type of physical activity occurs (Donnelly and Lambourne, 2011). PAAC promotes 90min/week of moderate to vigorous physically active academic lessons (3.0 to 6.0 METS, ~10 min each) delivered intermittently throughout the school day. Lessons were usually delivered in the classroom, but were also delivered in alternate school sites such as hallways and outdoors. PAAC lessons were used in a variety of academic areas including math, language arts, geography, history, spelling, science, and health (Donnelly *et al.*, 2009a). A recent review of physical activity and academic achievement showed a

positive association between PAAC and indicators of cognitive skills and attitudes, academic behaviour, and academic achievement (Kibbe *et al.*, 2011).

A successful program which is TAKE 10! program was developed by the non-profit organization, International Life Sciences Institute (ILSI) as a component of the Physical Activity and Nutrition (PAN) program. TAKE 10! was created in 1999 as a method of reducing sedentary behaviours during the elementary school day and to increase daily activity levels and structured minutes of PA in the classroom. The program integrates both PA and academic learning as students engage in 10-minute physical activities while specific learning objectives in math, reading, language arts, science, social studies, and general health are all reinforced. "Contraction Action" is one example of a TAKE 10! activity that can be implemented into the second grade setting. This activity incorporates both PA and academics as students sing and perform two-part muscle contraction movements to better understand how two words becomes a contracted word.

2.8 PAAC and academic performance

Physical Activity Across the Curriculum (PAAC) has been applied and reviewed to evaluate changes in academic achievement for reading, writing, mathematics, and oral language skills. The time span of the study by Donnelly and colleagues (2009) followed participants from grades two and three to grades four and five. The PAAC program promoted 90 minutes per week of moderate to vigorous intensity physical activities that promoted academic lessons provided by the classroom teacher. The Wechsler Individual Achievement Test- 2nd Edition was used to measure academic achievement. From baseline to year three, significant improvements were