Chapter 13

Physical Activity Practice, Sleeping Habits and Academic Achievement

Luis M. Ruiz-Pérez, Miguel A. Gómez-Ruano and José A. Navia-Manzano

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.71282

Abstract

There is a wide body of research that has identified the strong links between health behaviors and academic achievement. The media and official agencies strive to convey to schoolchildren and the public the need to show healthy lifestyles. However, it is striking that sleep habits have been considered in few occasions within healthy behaviors to be developed and promoted. Schools should encourage their students to be active because the effect of physical exercise will promote sleep and will positively affect the performance of academic tasks. Then, it is necessary to revitalize and establish the subject of Physical Education and Sport practice properly where the students can meet a minimum of 150 minutes of moderate-to-vigorous exercise per week. This approach will have a direct impact on the school children's performance and health. Therefore, the key question is to decide whether educational centers must promote active lifestyles where sleep and exercise will be promoting or maintain schools where the body and body intelligence remain an irrelevant matter.

Keywords: academic performance, health, childhood, adolescence, sleep habits, exercise

1. Introduction

Many variables impinge on college students' academic success. What do children and adolescents need to be academically successful? How children's and adolescent's health is related to academic achievement? Are physical activity practice and sleep habits components of children's and adolescent's health? Moreover, how these components affect the academic performance? are some of the key questions that this chapter tries to account for.

The available research has reported that increasing the physical activity practice is beneficial for children's and adolescent's health and education [1–4]. Thus, schools must focus their

attention on implementing physical activity interventions (e.g., increasing the number of physical education hours per week) with the aim to improve the pupils' health as well as to reduce the obesity levels among adolescents. Nevertheless, the physical education is considered a second layer in the educational process due to the concern of educative policies about reaching the adequate standards of academic achievements among students. Then, the educative policies establish the reduction and, in some cases, the elimination of physical education classes. The traditional education research considers that pupils should employ the time studying the theoretical subjects instead on spending time doing physical activities [5–9].

However, the recent research supports that physical activity practice is related with improvements in cognitive and memory functions of the brain [10]. In fact, the increase of physical activity may improve the school performance and academic achievements in children and adolescents [11]. For instance, it seems to exist a positive relationship between motor competence (achieved through physical activity practice) and academic performance [12]. Specifically, in the female students, the academic achievement was associated with the practice of vigorous physical activity, whereas in male students the academic achievement was associated with a greater extent with fitness [13]. Overall, the evidence supports that the practice of physical activity leads to improvements on both cognitive and academic performance [14, 15].

On the other hand, regular sleep is fundamental on health and growth of children and adolescents. Thus, the lack of sleep and sleep deprivation is associated with adverse physical and psychological consequences. The scientific research indicates that a good sleep quality is not only fundamental in determining a good health state, but it is also a main component for a good quality of life and academic performance [16]. For instance, it has been found that children and teenagers who suffer from circadian misalignment (i.e., insufficient sleep during the weekdays and oversleeping on weekends) have a lower academic, cognitive and sport performance than those who rest more regularly and with better sleep quality [3].

1.1. Health and education

There are a lot of researches that have showed the strong links between health behaviors, psychosocial behaviors and academic achievement [17]. International organizations, such as the World Health Organization, in their different proposals have stressed the need for schools to be the core of health promotion, which should be translated into curricular improvements proposed to develop healthy habits, and the involvement of families and social agents to support these initiatives. The objective is the development of skills and competences that favor the health of students and a better adaptation to life [18].

At present, studies that have analyzed the relationships between healthy behaviors and academic performance have increased markedly. However, what is referenced when talking about health and healthy behaviors? Health is a state of complete emotional and physical well-being. This concept during the school age has been focused on those who favor good nutrition; do not use tobacco, alcohol or drugs; do not show violent behaviors; practice safe sex and do not practice physical activity [19].

The media and official agencies strive to convey to schoolchildren and the public the need to show healthy lifestyles. As was pointed out by Sánchez [20], the effectiveness of these messages is determined, at least partially, by the direct cost and benefits of these behaviors to citizens. According to the results obtained, their effectiveness is put into question due to the obesity and sedentary pandemic situation in Western societies among the youngest [21]; increased consume of tobacco, alcohol and drugs among adolescents [22, 23]; increased cases of violence and bullying in schools [24, 25]; the increase of pregnant adolescents [17] or the increase of sedentarism of children and adolescents from different cultural backgrounds [26]. These issues affect the lives of children and adolescents and, therefore, have an impact on the decline of their academic performance [27]. It is striking that sleep habits have been considered in few occasions within healthy behaviors to be developed and promoted [27, 28]. In fact, it is well known that adolescents, who sleep less than 7 hours daily, have a higher risk of fail and drop out [29].

In sum, the scientific research has studied the main aspects of this chapter (i.e., physical activity, sleeping habits and academic achievement) in isolated conditions. However, there are few reviews of available research that relate either physical activity or academic achievement or sleep habits with physical activity practices or sleep habits with academic achievement [27]. Thus, the purpose of this chapter was to describe the relationships among these three variables and specifically how to practice physical activity and how sleep well affect the academic achievement of students throughout their academic life. Three areas of scientific literature have been analyzed to allow a better understanding of this problem: (i) literature about the relationships between physical activity practice and academic achievement; (ii) literature dealing with the relationships between sleep habits and academic achievement and (iii) literature reporting the effects of physical activity practice and sleep well on the health and academic achievement.

2. Physical activity and academic achievement

During the past 10 years, the effect of physical activity on academic achievement has become a more important topic with a growing number of scientific works published about this issue [30, 31]. Throughout this section, we (i) discuss the influence of physical activity upon academic achievement; (ii) analyze which psychophysiological effects of physical activity support that association and (iii) raise some recommendations of physical practice when aiming to improve the academic achievement. The academic performance can reflect several factors influencing the school success. For instance, Rasberry et al. [32] employed three categories: (a) cognitive skills and attitudes, (b) academic behaviors and (c) academic achievement. In this section, we focus our attention on the academic achievement defined as the test scores in subjects such as mathematics, reading, language art, social sciences and any other formal assessment regarding school areas or subjects.

2.1. More studying and less doing sports?

At a first glance, parents are concerned about the academic achievement of their children. Then, they may think that the involvement in physical activities could hamper the forthcoming

academic achievement, given that physical activity practice involves a great deal of effort and time. Hence, the time that boys and girls spend practicing physical activity results in a reduction of time dedicated to academic activities (i.e., studying, doing homework, reading, etc.). However, this does not seem to be applied to extracurricular activities like sports or extracurricular physical education. The scientific research has provided consistent evidence that time away from the sedentary study in favor of physical activities does not decrease the academic achievement [33, 34]. Some studies have proved that an increase for the amount of time dedicated towards physical activities (such as physical education or sport-related activities) does not impair the academic performance [35]. Furthermore, even when redistributing curriculum time in favor of aerobic physical activities, far from hinder, it improves the academic achievement of children [36]. Regarding the effort-demanding argument, one might think that the involvement in sports trainings could also lead to fatigue among children and adolescents. In fact, sedentary time (contrary to sports-related activities) is related to lower scores in academic tests (reading fluency, reading comprehension, arithmetic) [37]. Indeed, time spending for watching TV, playing videogames or interacting with mobile devices and social networks hinder the academic achievement [32]. In sum, scientific literature points towards a positive association between physical activity involvement and academic achievement among students from 4 to 18 years.

2.2. Physical activity and academic performance

2.2.1. Cross-sectional studies

A first group of cross-sectional studies informs about relationships of physical activity habits with the academic scores [38]. In this sense, self-reported time spent on physical activity is directly related (and screen time inversely) to higher scores among children aged between 11 and 18 years [39, 40]. Another research employing objectively measured tests has also found positive relationships between physical activity and academic achievement. For instance, the work by Dwyer et al. [41], which involved 7961 participants from 7 to 15 years, informed how academic achievement (5-point scale) was positively related (in all ages and in both sex) with cardiorespiratory endurance (i.e., 1.6 km run), muscular force (e.g., sit-ups) and time of physical activity. In another study where physical activity was monitored, lower academic performance (all domains: language, reading, spelling, writing and numeracy) was strongly related to higher levels of sedentary time among children (9–11 years old). In contrast, moderate-to-vigorous physical activity was related with writing and numeracy scores. Haapala et al. [42] reported that pupil between 6 and 8 years showed positive relationships between levels of physical activities (measured with accelerometers) and reading and arithmetic skills. Interestingly, the combination of lower levels of moderate-to-vigorous physical activity with high sedentary time was related to poorer reading skills (fluency and comprehension) in boys.

In another similar study, clear associations between moderate-to-vigorous physical activity and academic performance were not found among 10-year-old children [43]. In addition, academic achievement was positively correlated to both aerobic fitness (i.e., intermittent running field test) and motor skills measured with a battery of three test (i.e., catching with one hand, throwing at a wall target and shuttle run test). Along these lines, motor skill performance

seems to be directly related to academic achievement. For instance, poorer motor performance (i.e., shuttle run, balance and box and block tests) was associated with worse academic reading and arithmetic skills in children (6–8 years). More recently, Ruiz et al. [44] explored the relationships between academic achievements (expressed as the final mark of the participants across the academic year, in a 10-based scale) and the motor coordination (Test SportComp of motor coordination [45]) among youth students (11–16 years old). Their results showed weak, but consistent, positive relationships between 4 of 5 motor coordination tests and academic performances.

2.2.2. Longitudinal and intervention studies

Other studies have been focused on the effect of intervention in physical activity on academic achievement and/or that relationship across the time. For instance, Bezold et al. [46] published a vast longitudinal study with 83,111 children enrolled in grades 6–8 in the first year of the study. For 5 years, fitness scores (determined by three tests: aerobic capacity, pushup and curl-up tests) and academic performance (measured following Mathematics and English Language Arts test scores) were monitored. Both boys and girls who experienced a substantial increase in fitness resulted in an improvement in academic ranking by 0.36–0.38 percentiles compared with the reference group. In addition, in boys and girls, a substantial decrease in fitness was associated with significant decline in academic performance compared with the reference group. Then, pupils who increase their fitness also improved their academic achievement, whereas pupils who decreased their fitness worsened their scores. In another longitudinal study [47], the physical activity of fifth and seventh grade children was assessed (i.e., aerobic capacity, upper body strength and endurance, body composition, abdominal strength and endurance, flexibility and trunk extensor strength and flexibility) to detect children in the healthy fitness zone or children in the needs improvement zone. After 2 years, pupils who stayed in the healthy fitness zone had higher scores (in all academic domains: mathematics, reading, science and social studies) than those who remained in the needs improvement zone. The children who moved between healthy fitness zone and needs improvement zone (in any direction) obtained in between academic scores, indicating a longitudinal effect of fitness on academic achievement.

Donnelly et al. [48] carried out an intervention of 90 minutes of moderate-to-vigorous physical activity for 2 years with children from grades second and third. Children who received the intervention experimented improvements in all the academic domains: reading, composite, mathematics and spelling scores across the 3 years' baseline with respect to control schools. Other studies have investigated the effect of increasing physical activity among school-aged children. Despite some contradictory results [27, 49], the systematic review of intervention studies supports that physical activity is positively associate with the academic achievement [50].

2.2.3. Meta-analysis and systematic reviews

Stronger evidence of the benefits of physical activity on academic achievement arises from systematic reviews and meta-analyses [31, 32, 51–57]. In this sense, one of the first meta-analysis about cognitive functions reported a 0.25 of average effect size of physical activity cognitive functions [51]. Another meta-analysis [50] found that chronic physical activity interventions

had a significant small-to-moderate effect on cognition (effect size of 0.46) in youth (school age). Also, positive effects of physical activity interventions on cognition were identified when compared to no treatment (0.80). Other study [51], focused on secondary school (13–18 years old), revealed that most of the studies reviewed showed positive associations between moderate-to-vigorous physical activity and academic performance. Likewise, it has been reported that physical activity (all the types analyzed: resistance/circuit training, physical education programs, aerobic training), and regardless the methodology of study, has a significant effect (average of effect size of 0.32) on cognitive functions (measured as perceptual skills, academic readiness, achievement, math and verbal test) of school-aged children (aged 4–18 years).

A common concern expressed in the systematic reviews is the low methodological quality of part of the published works [41, 58]. Yet, when the risk of bias of existing studies is neatly assessed, positive associations between physical activity and academic achievement are found in all three cross-sectional, randomly controlled trials and longitudinal studies [47, 59]. In sum, a positive association between physical exercise programs and academic performance has been reported consistently by recent systematic reviews and meta-analyses [53].

2.3. Underlying processes of the effect of physical activity on academic achievement

As was previously seen, the available research has previously confirmed the plausible relationships between physical activity and the academic achievement. The next question to address would be what are the mediating factors among them? In other words, where does the effect of physical activity on academic achievement come from? To respond these questions, we consider the hypothetical model of factors proposed by Donnelly et al. [38] (**Figure 1**).

2.3.1. Cognitive functions

As Erickson et al. [60] claimed, higher fit and more active preadolescent children show more efficient patterns of brain activity and superior cognitive performance and scholastic achievement.

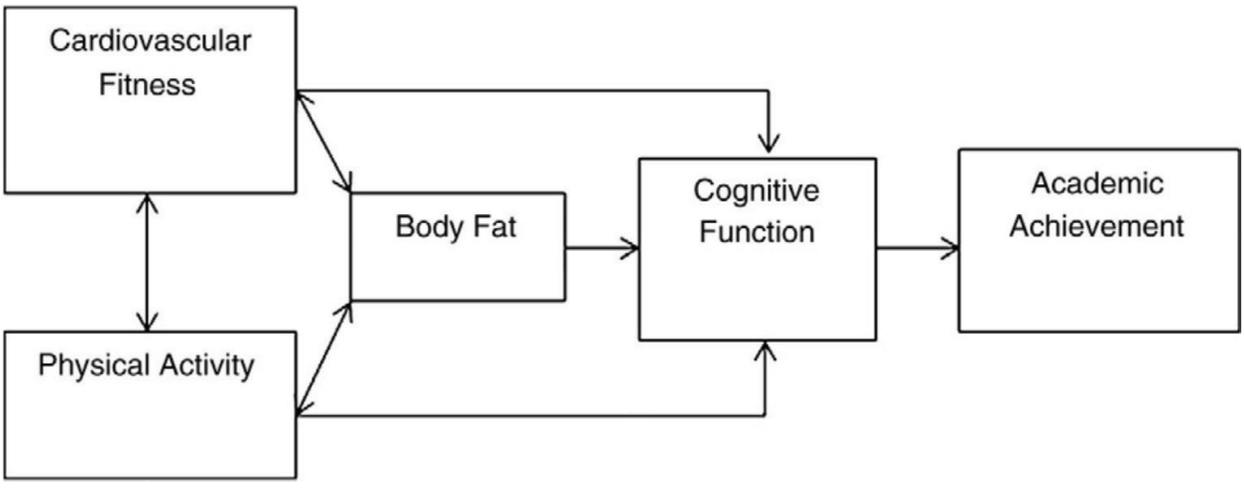

Figure 1. Hypothetical model of factors associated with improved academic achievement (from Donnelly and Lambourne [5]).

Several mechanisms underpin the effects of physical activity on cognitive functions during childhood and young adulthood: increased synaptic plasticity, cerebral circulation (blood volume), hippocampal neurogenesis, increases in neurochemicals (e.g., norepinephrine and dopamine), greater white matter integrity, upregulation of growth factors, efficiency of the prefrontal and parietal cortices and structural changes in the hippocampus and cerebellum [60–62]. These findings suggest that physical activity influences baseline electrocortical function and, thus, it might affect cognitive operations. In fact, a growing body of literature, including fMRI (functional magnetic resonance imaging) and ERP (event-related potential) studies, indicates that physical activity interventions produce improvements in brain function accompanied by improvements in executive functions [62].

For example, research indicates that when practicing moderate-to-vigorous aerobic exercises, prefrontal cortex and parietal/posterior cingulate cortex are activated to sustain the activity. These are relevant neural networks involved in complex cognitive functions, such as reading comprehension or mathematical calculations, which may support the positive relationships between both activities (i.e., physical and cognitive) [57]. More recently, neurophysiological-based studies pointed towards new connections between cognitive and motor functions, as the relationships of activation between prefrontal cortex and collateral cerebellum. This latter area is believed to play an important role not only in control and adaptation of movements but also in cognitive functions. In other words, improving the functioning of certain neural networks through physical exercise may benefit the academic performance.

2.3.2. Cardiovascular fitness

The review done by Chu et al. [63] highlighted positive associations between cardiorespiratory fitness and the academic achievement (total academic scores). Cardiorespiratory fitness has been consistently reported to exhibit a positive association with mathematics, social and science studies, spelling and language arts scores in both children and adolescents. Specifically, up to date, the available research is scarce when studying the relationships between cardiorespiratory adaptations and the academic achievement. For instance, cardiovascular performance (measured as maximal workload during cycloergometer exercise) does not seem to be associated with reading or arithmetic skills [64]. Another study supported the lack of relationship between cardiovascular capacity (heart rate) and the academic performance [65]. That is, cardiorespiratory fitness seems to improve the academic achievement by means of neurophysiological mediating effects rather than cardiorespiratory adaptations. For instance, children with higher cardiorespiratory fitness exhibited larger event-related brain potentials (ERBp), which are involved in neurocognitive process like cognitive operations [60]. Other associations among fitness measures like muscular strength, muscular endurance or flexibility with the academic achievement are unclear. They seem to have a positive relationship, but remains weak or unrelated when adjusted for potential mediators (i.e., socio-demographic factors, body mass index (BMI), etc.) [57, 60, 66].

Finally, the body of research suggests that other types of low-intensity trainings like practice motor skills may improve the cognitive performance. For instance, coordination training in adults (aimed to improve the efficiency of complex body movements) was associated with

better attentional control in visual search tasks [63]. The authors argued that those effects can be mediated by changes in brain functioning (i.e., frontal and parietal cortex), although research among children has not been conducted so far. In conclusion, positive relationships and associations between executive functions and physical activity have been found in terms of: (a) moderate-to-vigorous physical activity, (b) aerobic fitness and (c) motor skills [62].

2.3.3. Body fat

Obesity during school-age period has been proved to have detrimental effects on academic performance [5, 60]. However, high percentage of body fat does not hamper, by itself, the likelihood of academic success. In a recent study over 11,192 kindergartens, achievement scores were significantly lower in overweight children than in no overweight children in standardized tests of mathematics and reading. However, this association was no longer significant after the adjustment to race/ethnicity and socioeconomic status [9]. In another study upon 36,870 adolescents, it has been shown that physical activity can attenuate or even counteract negative association of fatness on academic achievement. In particular, fit adolescents (both high and low fatness) had higher odds for attaining high academic scores (in language and mathematics) than high fatness unfit counterparts. Also, low fatness adolescents were not more likely to reach higher scores in language than their high fatness fit peers [54]. Thus, physical activity seems to strongly mediate between obesity and academic achievement. Although the evidence of this mediator effect is limited, a promising research in this topic is envisaged [60]. Furthermore, as some researchers consider [67] that the association between elevated body mass index and decreased academic achievement was dependent on the extent to which obesity was stigmatized in the school.

3. Sleeping habits and health and human performance

Sleep constitutes a basic need, with durations between 8 and 9 hours depending on the age, that has direct effects on the human health and then on the human performances developed daily [68, 69]. The importance of this behavior is crucial in all the age stages, but with special relevance during childhood and adolescence [70]. The available research has widely investigated this issue under different perspectives such as healthy approaches, healthy programs, physiological needs, social influence, sleep and lifestyle, sleep disorders, sleep deprivation or sleep loss and academic performance [71–75]. The latest area has received greater analysis for children, adolescents, educators, parents and pediatrics due to the important effect on academic performances during the primary and secondary school and the university studies [71, 72, 76, 77]. The next sections of the chapter will try to go in depth about the key aspects that should be known and considered when studying the importance of sleep habits and health, the importance of sleep habits and academic performance in children and adolescents, the relationships between sleep habits and obesity and the importance of healthy programs to educate the children into positive sleep habits.

3.1. Sleep habits and health

Sleep is an active, repetitive and reversible state that promotes the development of physical, cognitive, affective and behavioral aspects. Sleep is necessary to maintain all the brain

functions affecting the good state of human memory, learning/memory capacity, the brain's optimal function or the neurobehavioral function [78–81]. Therefore, sleep habits are one of the most important daily routines that must be correctly done [82]. The absence, loss or deprivation of sleep has a direct effect on health problems [83–85]. However, when these disorders or inadequate sleep habits occur during the childhood or the adolescence, the academic performance and the physical and physiological development are highly compromised [86–88].

Nowadays, sleep loss is one of the problems that the people should face daily. Usually, it is preferable to sacrifice some of the time dedicated to sleep hoping that this time will not have a negative impact during our daily activities such as studying, working, etc. [83]. However, this behavior has a direct and negative effect on physical (fatigue), neurocognitive (impairment in learning and memory) and psychomotor performances (impairment in psychomotor activities) [89].

3.2. Sleep habits and academic performance in children and adolescents

Specifically, the importance of sleep loss increases during the childhood and the adolescence due to the important role that plays in learning capacity, school performance and memory consolidation [72, 73, 81]. During the school and college stages, the students cope with sleep problems, such as sleep deprivation or sleep restriction, which produces a poor sleep quality and then academic problems [73]. The specific literature refers to a mean of 9 hours per night of sleep as a good requirement; however, 45% of the students sleep less than 8 hours per night and around 20–50% considers that they have sleepiness during the day [77, 78, 80]. The reasons of this time sleep reduction can be an interaction of intrinsic (e.g., physical and physiological changes induced by the puberty) or extrinsic (e.g., school schedules, extracurricular activities, family lifestyle, etc.) factors that lead to go late to bed with the daily routines unchanged [90].

The consequence of this sleep loss is the sleepiness that the children and adolescents reflect during the day [68]. This fact reduces some neurobehavioral aspects of learning and memory, such as reduced alertness and decision-making, or difficulties when performing complex tasks (i.e., that require the use of the prefrontal cortex) during planning, integrative processes or abstract thinking [80, 91]. According to this rationale, the sleep loss appears during the stages from school to the university affecting the learning process and the academic performance in the different lessons (i.e., practice, laboratories, theory or exams) received by the students [84, 85, 88].

3.2.1. The importance of sleep-wake cycle and the delayed phase preference

The physiological explanations of sleep loss are the changes that occur during the sleep-wake cycle caused by going to bed late and waking up early in the morning. The sleep-wake cycle is composed of two opposing processes: the circadian rhythm (described as a natural clock synchronized with the external time and regulates the wakefulness) and the homeostatic drive for sleep (process that increases sleepiness with the accumulated time awake and decreases when sleeping) [79]. The changes of this cycle appear with greater intensity during the adolescence with changes in the students' chronotype due to the delayed phase preference [80]. This delay is not only social, cultural or psychological [79, 81] and is affected by biological

processes associated to the puberty (biological factors that slow down the circadian oscillation process and the homeostatic drive for sleep) [81]. The importance of sleep-wake cycle can be associated to the cognitive performance in youth students. Kirby et al. [69] explained that it depends on the time of the day where the accumulation of drive for sleep process increases or decreases the sleep pressure. This mainly occurs during the waking up hours, early in the morning, after eating or with a high sleep debt.

3.2.2. The relationships between sleep and learning-memory processes

As was previously described, the sleep-wake cycle modifies the cognitive performances according to the sleep loss. This process affects the learning and memory processes during the academic activities. Specifically, the memory can be divided into: (i) the procedural/non-declarative memory (i.e., knowing how to do a skill or solve a problem) that involves the visual, motor or verbal domains and is gained during the rapid eye movement (REM) sleep and (ii) the declarative memory (i.e., knowing that) that links to the related conscious collection of information and is restored in the no rapid eye movement (NREM) sleep. Both sleep phases (i.e., REM and NREM) are crucial for the learning and memory processes performed during the academic activities. Thus, the sleep deprivation or sleep loss is the great enemy for children and adolescent during the learning stages [65, 68].

In order to summarize the effects of sleep loss and the sleep-wake cycle on the academic performance, we can point out the following key issues [69]: (i) the attention and working memory are more affected by the circadian rhythm (synchronicity effects of optimal performance in specific moments of the day) than the procedural memory [69]; (ii) the optimal performances for executive functions are later in the day [86] and (iii) the sleep debt contributes to learning difficulties on concentration, memory, complex thinking or planning tasks [83]. Accordingly, the schedules established for schools, colleges and universities may impose an early starting time that impairs the students' abilities to perform at their best level due to their sleep loss and the sleep debts accumulated along the week [68].

3.2.3. Sleep loss and academic performance

The correlations between sleep loss and academic performance have been largely studied using self-reported surveys, grade point average (GPA), parents' or teachers' reports or the analysis of school behaviors [65, 68]. The main conclusion obtained in this research area is that the children's fatigue associated to poor sleep (i.e., quality of sleep) is the best predictor of lower school/college/university performances [70, 71, 73]. Thus, this fact shows a tendency of those students to fall asleep during school time, lose their concentration easily and not focus their attention on the relevant information. More specifically, during the sleep loss, the prefrontal cortex and its neural activity highly affect the divergent thinking, language speech, memory, decision-making, attention, mood, learning processes, critical thinking, creativity or performing complex tasks [66].

The available studies have showed this negative relationship between sleep and academic performance in primary and secondary schools [78] as well as at the university level [76]. The authors referred that the sleepiness produced by the poor quality of sleep impairs the above-mentioned,

learning, cognitive and neurobehavioral function [65, 68]. Regarding to this relationship, some factors should be controlled for when trying to identify the reasons of this sleep loss and then the poor performance. According to the scientific research [69, 70], some aspects may modify the sleep schedules in both the intrinsic and extrinsic factors. On the one hand, the intrinsic factors can be affected by the students' level of stress due to academic pressure [65, 72, 78] or close schedules [69, 75] that induce to a high-pressure level of tension, anxiety and feelings of stress that disrupt or modify the circadian rhythms [65, 81]. On the other hand, the extrinsic factors can be associated to the high number of hours after the school doing extracurricular activities [72, 73]; the social factors that modify the schedules such as the adolescent life, the campus life or love relationships [74, 76]; the use of afternoon naps [75]; the importance of time watching TV, internet or playing videogames [78]; the influence of the sleep debts during the course (e.g., more fatigue during the second semester) [75] or the weekday or weekend day routines (i.e., the weekend may make up the sleep lost accumulated during the week, but dramatic changes can occur in the sleep-wake cycle if the students increase dramatically the number of hours of sleep) [77].

In addition, the sleep behavior during the childhood and adolescence should maintain an adequate number of hours of sleep and good quality of sleep to avoid a chronic pattern of sleep that would have a negative impact on cognitive, performance, learning, neurobehavioral and mood aspects [73, 76].

3.2.4. Sleep loss and physical performance

The influence of sleep loss and physical/psychomotor performance has been studied in different contexts. When analyzing the psychomotor performance at the school, the studies [83, 84] did not report significant effects of sleep deprivation on motor performances of students. In fact, the only relative significant results were identified with more than 30 hours of sleep deprivation on endurance, agility, balance, strength and speed [83, 84]. However, if we consider the academic activities of physical education subject at the school, the number of hours per week and the intensity of its activities may explain the non-significant results due to the low impact performance developed during the lessons.

On the other hand, if we analyze the athletes' context, where they must perform at their highest level, the studies are showing an important effect of sleep loss and physical performance [87]. The athletes can only perform at their optimal level when the sleep habits are hygienic and favorable [87]. It is suggested that the athlete should sleep around 8–9 hours per night to recover and repair their tissues after trainings and competitions. To do so, both sleep phases (REM and NREM) must be covered to have the adequate psychological, hormonal (e.g., growth hormone secretion) and glucose metabolism processes [85]. Additionally, the sleep deprivation in athletes may result in an imbalance of the autonomous nervous system, the immune system and the cognitive function and then simulate the overtraining syndrome symptoms [88, 89]. In fact, sleep deprivation may create a disturbance of the athlete's sleep-wake cycle independent of the fatigue process suffered by trainings and competitions [85], suggesting that the athletes perform better the complex skills early in the day than gross motor skills (better performances late in the day) due to the circadian rhythm alertness [85, 89].

3.3. Sleep habits and obesity

One of the intriguing relationships of sleep habits and health is the research findings of sleep patterns and obesity. The scientific research has raised the importance of sedentary lifestyle in overweight and obesity. Insufficient sleep plays a critical role in children with overweight and predicts body mass index (BMI) when the students also do sedentary activities [92]. The mechanism associated to the lack of sleep is the level of hormones regulating the body appetite due to a decrease of leptin secretion and an increase of the ghrelin [92]. This mechanism creates an imbalance of both hormones increasing the feelings of hungry and the need to intake foods and then the incidence of overweight and obesity, coronary heart disease, type 2 diabetes or hypertension [73, 78, 92]. Additionally, this relationship appears to have another influence on obese/overweight student's physical growth, the reduction in height [73, 78, 92]. The main body of research of different countries [92] showed negative correlations between sleep deprivation and BMI and positive correlations with height [78, 92]. This result has a gender effect with female students having less sleep deprivation and environmental pressure than their male mates, reflecting a greater prevalence of obesity in male students with less sleep [92].

3.3.1. Sleep breathing disorders

Some studies also related the students facing with sleep breathing disorders, such as obstructive sleep apnea (OSA) or insomnia, to poor academic performances [65, 68]. These disorders include difficulties to maintain sleep, snoring, insomnia or waking up early in the morning. Then, these students have more problems to perform correctly at the school due to the sleep debt that limits the attention, working memory or learning processes [92]. In fact, these students need to have a nap to adjust their sleep requirements; however, this behavior modifies the sleep-wake cycle and then their neurocognitive and behavioral domains and the increase of BMI [65, 68, 92]. Therefore, from an educational point of view, the students with sleep breathing disorders should be considered when planning specific sleep educational programs.

4. Sleep and exercise well during the growing years

In this chapter, the associations of two health behaviors, such as physical activity and sleep habits with academic achievement of students, have been explored. This analysis allows us to state that there are many more relationships among them than could be thought in a first instance [27].

It should be said that if you want to lead a healthy and satisfying life, you should start sleeping well and practice physical activity. The lack of sleep is related to a whole set of diseases that are not conducive to the health of individuals independently of the age of the student. On the other hand, it has been widely demonstrated that good sleep is a key aspect to personal performance. The scientific research has demonstrated the relationships among sleep loss, academic outcomes and school drop-out in adolescent students. The exams encourage adolescents to significantly reduce sleep, drink energetic drinks [85] and adopt sedentary attitudes that may favor the possibility of higher levels of anxiety and stress on the students

reducing their performances. Indeed, if sleep is a vital element on the students' health, the regular practice of physical exercise is also a key factor. The scientific research has demonstrated that physical activity improves sleep and then the cardiovascular system, allowing to a better sleep quality. In addition, Flueckiger et al. [27] consider that sleep predicts better achievement than physical activity (i.e., students with higher overall sleep quality had better academic achievement).

Schools should encourage their students to be active and they should self-promote it for many reasons. Specifically, as has been widely commented, the effect of physical exercise will promote sleep and will have a direct impact on the performance of academic tasks. It is necessary to revitalize and put the Physical Education and Sports subject in the correct place that deserves during the school age [2, 12]. This approach requires that the students can have a minimum of 150 minutes of moderate-to-vigorous exercise per week, as this physical activity will have a direct impact on the performance of schoolchildren and their health. Marshall and Hardman [96] claimed that physical education is in a perilous position in all continental regions of the world. However, the problems of status, curricula, implementation, time allocation, financial support, human resources, teacher preparation and attitude of headteachers, parents and other teachers increase the skepticism about its future.

The key question is to decide: what do we need in the education of children and adolescents. Then, we must decide between two educational options, the first one focused on educational centers where active lifestyles are promoted, and sleep and exercise are present; or the second one focused on active schools in which the general behavior of their members is manifested in healthy behaviors and healthy attitudes, and active school environments, and that favor an embodied educational work and the performance of the students.

5. Concluding remarks

Based on this extensive body of research, some suggestions can be outlined to optimize the effect of physical activity and sleep habits on the academic achievement. Researches findings suggest positive benefits of physical activity throughout a wide range of academic ages, from kindergarten [11] until college [51, 93]. Scientific literature suggests uneven effects as a function of the age, remarking greater effect of physical activity on academic performance in primary school (6–13 years old) in comparison with adolescents (14–18 years old). Thus, students should be encouraged to practice physical activities in early periods of primary school to maximize the potential benefits over the academic achievement [55, 94].

The meta-analysis done by Fedewa and Ahn [95] examined different interventions on children's cognitive outcomes (mathematics, science, reading, English/language, art achievement, grade point average and intellectual quotient). The results showed that, unlike resistance/circuit training and their combinations, aerobic training, physical education program and perceptual motor training (in that order) significantly affected the academic achievement [46]. Other authors stated that there is still no clear evidence regarding which programs are more effective for cognitive performance. The aerobic and motor skills programs (both combined with cognitive engaging) seem to be the most efficient ones [31]. In the same terms, other studies confirm

that the aerobic capacity confers the greatest effect on academic achievement [47]. There is strong evidence that supports the positive association between both cardiorespiratory fitness and physical fitness (classified into clusters) with academic achievement, whereas the relationship between strength and flexibility remains unclear [59]. Regarding intensity, while there are some researches that relate the practice of moderate physical activity with positive academic benefits, the practice of vigorous and moderate-to-vigorous levels of physical activity has been found to provide greater positive effects on the academic achievement [14].

On the other hand, the frequency is a key issue when controlling for physical activity and academic performance. The effect of physical activity has been proved to report significantly higher benefits when provided three and two times per week (i.e., better improvements with a frequency of three times per week). Moreover, it has been identified a positive correlation between the improvement of academic performances and attending three or more physical education classes per week was positively correlated with improved academic school performances [96]. Accordingly, we highly recommend the practice of aerobic fitness and motor skills training, with a minimum intensity of moderate-to-vigorous and with a frequency of 3 days per week, as the optimal physical activity plan for enhancing academic achievement.

On the other hand, sleep hygiene programs can be implemented to improve the students' health and the effect of sleep quality on the academic performance. The educational stakeholders should implement the sleep hygiene programs focused on the importance of sleep habits and their relationships with academic performance [15, 30, 32, 40]. To do so, the families should establish balanced schedules that combine academic and leisure activities; the children/adolescents should establish a sleep pattern, going to bed early avoiding TV or leisure activities during the week nights and educators and pediatrics should give tips and feedbacks (e.g., avoid afternoon naps, restrict caffeine, do not go to bed immediately after high demanding exercise and sleep without excessive noise and light) for quality sleep advices with annual health examinations [15, 30, 32]. The implementation of these sleep programs would do more than be informative on the importance of sleep hygiene on health and academic performance [40]. It is necessary to teach schoolchildren to sleep well and promote a long-term perspective of the benefits of physical exercise. Therefore, schools should consider their schedules to adjust them to the moments of the day where greater academic and physical performance is possible [82].

Summarizing, the health-promoting school literature shows its potential to improve students' development, both academically and health related. The current chapter adds up to this effort by elaborating on the specific relations of sleep and exercise habits on the academic performance. There is another behavior that significantly affects the adolescents' psychosocial and academic development, such as bullying and compulsive internet use, and not just more traditional healthy topics with strong ties to physical health, such as smoking or alcohol use.

Unfortunately, much is still unknown about the effects that improving health behaviors might have on students' school performances. Indeed, it was justified the need for further research on this topic. Research on mechanisms behind the associations between these health behaviors and school performance is scarce and not conclusive. Therefore, further studies on the explanatory factors are required.

Author details

Luis M. Ruiz-Pérez*, Miguel A. Gómez-Ruano and José A. Navia-Manzano

*Address all correspondence to: luismiguel.ruiz@upm.es

Faculty of Physical Activity and Sport Sciences (INEF), Technical University of Madrid, Spain

References

[1] Baker PR, Francis DP, Soares J, Weightman AL, Foster C. Community wide interventions for increasing physical activity. Cochrane Database of Systematic Reviews (Online). 2011;**13**(4):CD008366

[2] Bailey R, Armour K, Kirk D, Jess M, Pickup R, Stanford R, BERA PE. Sport pedagogy special interest group the educational benefits claimed for physical education and school sport: An academic review. Research Papers in Education. 2009;**24**(1):1-27. DOI: 10.1080/02671520701809817

[3] Díaz-Morales JF, Escribano C. Social jetlag, academic achievement and cognitive performance: Understanding gender/sex differences. Chronobiology International. 2015; **32**:822-831

[4] Keteyian SJ. Exercise training in congestive heart failure: Risks and benefits. Progress in Cardiovascular Diseases. 2011;**53**(6):419-428

[5] Donnelly JE, Lambourne K. Classroom-based physical activity, cognition, and academic achievement. Preventive Medicine Journal. 2011;**52**(Suppl 1):S36-S42

[6] Bailey R. Physical education and sport in schools: A review of benefits and outcomes. Journal of School Health. 2006;**76**(8):397-401

[7] Casajus JA, Leiva MT, Villarroya A, Legaz A, Moreno LA. Physical performance and school physical education in overweight Spanish children. Annals of Nutrition & Metabolism. 2007;**51**:200-296

[8] Cluxton G. Intelligence in the Flesh. Why Your Mind Needs Your Body Much More Than it Thinks. New Haven: Yale University Press; 2015

[9] Datar A, Sturm R, Magnabosco JL. Childhood overweight and academic performance. National study of kindergarten and first-graders. Obesity Research. 2004;**12**:58-68

[10] Flöel A, Ruscheweyh R, Krüger K, Willemer C, Winter B, Völker K, Lohmann H, Zitzmann M, Mooren F, Breitenstein C, Knecht S. Physical activity and memory functions: Are neurotrophins and cerebral gray matter volume the missing link? NeuroImage. 2010;**49**(3):2756-2763

[11] Sibley BA, Etnier JL. The relationship between physical activity and cognition in children: A meta-analysis. Pediatric Exercise Science. 2003;**15**:243-256

[12] Ardoy DN, Fernández-Rodríguez JM, Jiménez-Pavón D, Castillo R, Ruiz-Ruiz J, Ortega FBA. Physical education trial improves adolescents 'cognitive performance and academic achievement: The EDUFIT study. Scandinavian Journal of Medicine & Science in Sports. 2013;**24**:e52-e61. DOI: 10.1111/sms.12093

[13] Kwak L, Kremers SPJ, Bergman P, Ruiz JR, Rizzo NS, Sjöström M. Associations between physical activity, fitness, and academic achievement. The Journal of Pediatrics. 2009; **155**:914-918

[14] Esteban-Cornejo I. Physical activity and cognition in adolescents: A systematic review. Journal of Science and Medicine of Sport. 2014;**18**(5):534-539. DOI: http://dx.doi.org/10.1016/j.jsams. 2014.07.007

[15] Howie E, Patie RR. Physical activity and academic achievement in children: A historical perspective. Journal of Sport and Health Science. 2012;**1**:160-169 http://dx.doi.org/10.1016/j.jshs.2012.09.003

[16] Sierra JC, Jiménez-Navarro C, Martín-Ortiz JD. Calidad del sueño en estudiantes universitarios: importancia de la higiene del sueño. Salud Mental. 2002;**25**(6):35-43

[17] Busch V, Laininga-Wijnen L, Schrijver's AJP, De Leeuw JRJ. Associations of health behaviors, school performance and psychosocial problems in adolescents in The Netherlands. Health Promotion International. 2017;**32**(2):280-291. DOI: 10.1093/heapro/dav058.2015

[18] Clift S, Jensen BB, editors. The Health Promoting School: International Advances in Theory, Evaluation and Practice. Copenhagen: Danish University of Education Press; 2005

[19] Bradley BJ, Greene AC. Do health and education agencies in the United States share responsibility for academic achievement and health? A review of 25 years of evidence about the relationship of adolescents' academic achievement and health behaviors. Journal of Adolescent Health. 2013;**52**:523-532

[20] Sánchez JC. Efectos de la presentación del mensaje para realizar conductas saludables: el papel de la autoeficacia y de la motivación cognitiva. International Journal of Clinical and Health Psychology. 2005;**6**(3):613-630

[21] Tremblay M, Leblanc A, Kho M, Saunders T, Larouche R, Colley R, et al. Systematic review of sedentary behavior and health indicators in school-aged children and youth. International Journal of Behavioral Nutrition and Physical Activity. 2011;**8**(98):2011

[22] Balsa AI, Giuliano LM, French MT. The effects of alcohol use on academic achievement in high school. Economics of Education Review. 2011;**30**:1-15

[23] Pennanen M, Haukkala A, De Vries H, Vartiainen E. Longitudinal study of relations between school achievement and smoking behavior among secondary school students in Finland: Results of the ESFA study. Substance Use and Misuse. 2011;**46**:569-579

[24] Beran TN, Lupart J. The relationship between school achievement and peer harassment in Canadian adolescents the importance of mediating factors. School Psychology International. 2009;**30**:75-91

[25] Juvonen J, Nishina A, Graham S. Peer harassment, psychological adjustment, and school functioning in early adolescence. Journal of Educational Psychology. 2000;**92**:349-359

[26] Eitle TM, Eitle DJ. Race, cultural capital, and the educational effects of participation in sports. Sociology of Education. 2002;**75**:123-146

[27] Flueckiger L, Lieb R, Meyer AH, Mata J. How health behaviors relate to academic performance via affect: An intensive longitudinal study. PLoS One. 2014;**9**(10):e111080. DOI: 10.1371/journal.pone.0111080

[28] Trockel MT, Barnes MD, Egget DL. Health-related variables and academic performance among first-year college students: Implications for sleep and other behavior. Journal of American College Health. 2000;**49**:125-138

[29] Titova OE, Hogenkamp PS, Jacobsson JA, Feldman I, Schiöth HB, Benedic C. Associations of self-reported sleep disturbance and duration with academic failure in community-swelling Swedish adolescents: Sleep and academic performance at school. Sleep Medicine. 2015;**10**:87-93

[30] Castelli DM, Centeio EE, Hwang J, Barcelona JM, Glowacki EM, Calvert HG, et al. The history of physical activity and academic performance research: Informing the future. Monographs of the Society for Research in Child Development. 2014;**79**(4):119-148

[31] Howie EK, Pate RR. Physical activity and academic achievement in children: A historical perspective. Journal of Sport and Health Science. 2012;**1**(3):160-169

[32] Rasberry CN, Lee SM, Robin L, Laris BA, Russell LA, Coyle KK, et al. The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. Preventive Medicine. 2011;**52**(Suppl 1): S10-S20

[33] Cooper H, Valentine JC, Barbara N, Lindsay JJ. Relationships between five after-school activities and academic achievement. Journal of Educational Psychology. 1999; **91**(2):369-378

[34] Carlson SA, Fulton JE, Lee SM, Maynard LM, Brown DR, Harold W, Kohl I, et al. Physical education and academic achievement in elementary school: Data from the early childhood longitudinal study. American Journal of Public Health. 2008;**98**(4):721-727

[35] Ahamed Y, Macdonald H, Reed K, Naylor PJ, Liu-Ambrose T, McKay H. School-based physical activity does not compromise children's academic performance. Medicine and Science in Sports and Exercise. 2007;**39**(2):371-376

[36] Shephard RJ. Habitual physical activity and academic performance. Nutrition reviews. 1996;**54**(4 Pt 2):S32-S36

[37] Haapala EA, Väistö J, Lintu N, Westgate K, Ekelund U, Poikkeus A-M, et al. Physical activity and sedentary time in relation to academic achievement in children. Journal of Science and Medicine in Sport. 2017;**20**(6):583-589

[38] Donnelly JE, Hillman CH, Castelli D, Etnier JL, Lee S, Tomporowski P, et al. Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. Medicine & Science in Sports & Exercise. 2016;**48**(6):1197-1222

[39] Fox CK, Barr-Anderson D, Neumark-Sztainer D, Wall M. Physical activity and sports team participation: Associations with academic outcomes in middle school and high school students. Journal of School Health. 2010;**80**(1):31-37

[40] SyvÄOja HJ, Kantomaa MT, Ahonen T, Hakonen H, KankaanpÄÄ A, Tammelin TH. Physical activity, sedentary behavior, and academic performance in Finnish children. Medicine & Science in Sports & Exercise. 2013;**45**(11):2098-2104

[41] Dwyer T, Sallis JF, Blizzard L, Lazarus R, Dean K. Relation of academic performance to physical activity and fitness in children. Pediatric Exercise Science. 2001;**13**(3):225-237

[42] Haapala EA, Poikkeus AM, Tompuri T, Kukkonen-Harjula KT, LeppÄNen PH, Lindi V, et al. Associations of motor and cardiovascular performance with academic skills in children. Medicine & Science in Sports & Exercise. 2014;**46**(5):1016-1024

[43] Aadland KN, Moe VF, Aadland E, Anderssen SA, Resaland GK, Ommundsen Y. Relationships between physical activity, sedentary time, aerobic fitness, motor skills and executive function and academic performance in children. Mental Health and Physical Activity. 2017;**12**:10-18

[44] Ruiz LM, Navia JA, Ruiz A, Ramón I, Palomo M. Coordinación motriz y rendimiento académico en adolescentes. Retos. 2016;**29**:86-89

[45] Ruiz LM, Barriopedro MI, Ramón I, Palomo M, Rioja N, García V, et al. Evaluar la Coordinación Motriz Global en Educación Secundaria: El Test Motor SportComp. RICYDE. Revista Internacional de Ciencias del Deporte. 2017;**49**:285-301. DOI: 10.5232/ricyde2017.04907

[46] Bezold CP, Konty KJ, Day SE, Berger M, Harr L, Larkin M, et al. The effects of changes in physical fitness on academic performance among New York City youth. Journal of Adolescent Health. 2014;**55**(6):774-781

[47] Wittberg RA, Northrup KL, Cottrell LA. Children's aerobic fitness and academic achievement: A longitudinal examination of students during their fifth and seventh grade years. American Journal of Public Health. 2012;**102**(12):2303-2307

[48] Donnelly JE, Greene JL, Gibson CA, Smith BK, Washburn RA, Sullivan DK, et al. Physical activity across the curriculum (PAAC): A randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. Preventive Medicine Journal. 2009;**49**(4):336-341

[49] Jäger K, Schmidt M, Conzelmann A, Roebers CM. The effects of qualitatively different acute physical activity interventions in real-world settings on executive functions in pre-adolescent children. Mental Health and Physical Activity. 2015;**9**:1-9

[50] Lees C, Hopkins J. Effect of aerobic exercise on cognition, academic achievement, and psychosocial function in children: A systematic review of randomized control trials. Preventing Chronic Disease. 2013;**10**:E174

[51] Etnier JL, Salazar W. The influence of physical fitness and exercise upon cognitive functioning: A meta-analysis. Journal of Sport & Exercise Psychology. 1997;**19**(3):249

[52] Sibley BA, Etnier JL. The relationship between physical activity and cognition in children: A meta-analysis. Pediatric Exercise Science. 2003;**15**(3):243

[53] Esteban-Cornejo I, Tejero-Gonzalez C, Sallis JF, Veiga OL. Physical activity and cognition in adolescents: A systematic review. Journal of Science and Medicine in Sport. 2015;**18**(5):534-539

[54] García-Hermoso A, Esteban-Cornejo I, Olloquequi J, Ramírez-Vélez R. Cardiorespiratory fitness and muscular strength as mediators of the influence of fatness on academic achievement. The Journal of Pediatrics. 2017. DOI: 10.1016/j.jpeds.2017.04.037 [Epub ahead of print]

[55] Álvarez-Bueno C, Pesce C, Cavero-Redondo I, Sánchez-López M, Pardo-Guijarro MJ, Martínez-Vizcaíno V. Association of physical activity with cognition, metacognition and academic performance in children and adolescents: A protocol for systematic review and meta-analysis. BMJ Open. 2016;**6**(6):e011065-e

[56] Vazou S, Pesce C, Lakes K, Smiley-Oyen A. More than one road leads to Rome: A narrative review and meta-analysis of physical activity intervention effects on cognition in youth. International Journal of Sport and Exercise Psychology. 2016:1-26. DOI: doi.org/10.1080/1612197X.2016.1223423

[57] Singh A, Uijtdewilligen L, Twisk JR, van Mechelen W, Chinapaw MM. Physical activity and performance at school: A systematic review of the literature including a methodological quality assessment. Archives of Pediatrics & Adolescent Medicine. 2012;**166**(1):49-55

[58] Poitra VJ, Gray CE, Borghese MM, Carson V, Chaput J-P, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. Applied Physiology, Nutrition & Metabolism. 2016;**41**:S197-S239

[59] Santana CCA, Azevedo LB, Cattuzzo MT, Hill JO, Andrade LP, Prado WL. Physical fitness and academic performance in youth: A systematic review. Scandinavian Journal of Medicine & Science in Sports. 2017;**27**(6):579-603

[60] Erickson KI, Hillman CH, Kramer AF. Physical activity, brain, and cognition. Current Opinion in Behavioral Sciences. 2015;**4**:27-32

[61] Hillman CH, Erickson KI, Kramer AF. Be smart, exercise your heart: Exercise effects on brain and cognition. Nature Reviews Neuroscience. 2008;**9**(1):58-65

[62] Best JR, Miller PH. A developmental perspective on executive function. Child Development. 2010;**81**(6):1641-1660

[63] Chu C-H, Chen F-T, Pontifex MB, Sun Y, Chang Y-K. Health-related physical fitness, academic achievement, and neuroelectric measures in children and adolescents. International Journal of Sport and Exercise Psychology. 2016:1-16. DOI: 10.1080/1612197X.2016.1223420

[64] Hötting K, Röder B. Beneficial effects of physical exercise on neuroplasticity and cognition. Neuroscience & Biobehavioral Reviews. 2013;**37**(9, Part B):2243-2257

[65] Giuseppe C, Ferrara M, De Gennaro L. Sleep loss, learning capacity and academic performance. Sleep Medicine Review. 2006;**10**(5):323-337

[66] Wittberg RA, Cottrell LA, Davis CL, Northrup KL. Aerobic fitness thresholds associated with fifth grade academic achievement. American Journal of Health Education. 2010;**41**(5):284-291

[67] Crosnoe R, Muller C. Body mass index, academic achievement, and school context: Examining the educational experiences of adolescents at risk of obesity. Journal of Health and Social behavior. 2004;**45**:393-407

[68] Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bögels SM. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. Sleep Medicine Reviews. 2010;**14**(3):179-189

[69] Kirby M, Maggi S, D'Angiulli A. School start times and the sleep–wake cycle of adolescents: A review and critical evaluation of available evidence. Educational Researcher. 2011; **40**(2): 56-61

[70] Carskadon MA, Harvey K, Dement William C. Sleep loss in young adolescents. Sleep. 1981;**4**(3):299-312

[71] Noland H. Adolescents' sleep behaviors and perceptions of sleep. Journal of School Health. 2009;**79**(5):224-230

[72] Mak KK. Sleep and academic performance in Hong Kong adolescents. Journal of School Health. 2012;**82**(11):522-527

[73] Yeung WF, Chung KF, Chan T. Sleep–wake habits, excessive daytime sleepiness and academic performance among medical students in Hong Kong. Biological Rhythm Research. 2008;**39**(4):369-377

[74] Johns MW. A new method for measuring daytime sleepiness: The Epworth sleepiness scale. Sleep. 1991;**14**(6):540-545

[75] Liguori G, John S, Mozumdar A. Semester long changes in sleep duration for college students. College Student Journal. 2011;**45**(3):481-493

[76] Wagner M, Rhee Y. Stress, sleep, grief: Are college students receiving information that interests them? College Student Journal. 2013;**47**(1):24-33

[77] Yang CM, Spielman AJ. The effect of a delayed weekend sleep pattern on sleep and morning functioning. Psychology and Health. 2001;**16**(6):715-725

[78] Zhang LJ, Hui-Shan W, Xiao-Na H. Sleep patterns amongst Chinese children. Biological Rhythm Research. 2010;**41**(3):203-215

[79] Blatter K, Cajochen C. Circadian rhythms in cognitive performance: Methodological constraints, protocols, theoretical underpinnings. Physiology & Behavior. 2007;**90**(2):196-208

[80] Crowley SJ, Acebo C, Carskadon MA. Sleep, circadian rhythms, and delayed phase in adolescence. Sleep Medicine. 2007;**8**(6):602-612

[81] Mitru G, Millroo DL, Mateika JH. The impact of sleep on learning and behavior in adolescents. Teachers College Record. 2002;**104**(4):704-726

[82] Huffington A. The Sleep Revolution. New York: Harmony Books; 2016

[83] Carskadon MA. When worlds collide: Adolescent need for sleep versus societal demands. Phi, Delta. Kappa. 1998;**80**(5):348

[84] Copes K, Rosentswieg J. The effects of sleep deprivation upon motor performance of ninth-grade students. The Journal of Sports Medicine and Physical Fitness. 1972;**12**(1):47

[85] Reilly T, Edwards B. Altered sleep–wake cycles and physical performance in athletes. Physiology & behaviour. 2007;**90**(2):274-284

[86] Yoon C, May CP, Hasher L. Aging, circadian arousal patterns, and cognition. Cognition, Aging, and Self-reports. In Schwartz N, Park D, Knauper B, Sudman S (Eds.). Philadelphia, PA, US: Psychology Press; 1999. p. 117-143

[87] Cummiskey J. Sleep and athletic performance. European Journal of Sports Medicine. 2013;**1**(1):13-22

[88] Fullagar HHK. Sleep and athletic performance: The effects of sleep loss on exercise performance, and physiological and cognitive responses to exercise. Sports Medicine. 2015;**45**(2):161-186

[89] Garcia-Mas A, Aguado FJ. Sueño, descanso y rendimiento en jóvenes deportistas de competición. Revista de Psicología del Deporte. 2003;**12**(2):181-195

[90] Eliasson AH, Lettieri CJ, Eliasson AH. Early to bed, early to rise! Sleep habits and academic performance in college students. Sleep and Breathing. 2010;**14**(1):71-75

[91] Hillman CH, Pontifex MB, Motl RW, O'Leary KC, Johnson CR, Scudder MR, et al. From ERPs to academics. Developmental Cognitive Neuroscience. 2012;(**2** Suppl 1):S90-SS8

[92] Busto-Zapico R. Relationships between sleeping habits, sedentary leisure activities and childhood overweight and obesity. Psychology, Health & Medicine. 2014;**19**(6):667-672

[93] Flynn JI, Piazza AK, Ode JJ. The association between study time, grade point average and physical activity participation in college students: 2290: Board #178 May 28 3:30 PM - 5:00 PM. Medicine & Science in Sports & Exercise. 2009;**41**(5):297

[94] Kim S-Y. So W-Y. The relationship between school performance and the number of physical education classes attended by Korean adolescent students. Journal of Sports Science & Medicine. 2012;**11**(2):226-230

[95] Fedewa AL, Ahn S. The effects of physical activity and physical fitness on Children's achievement and cognitive outcomes. Research Quarterly for Exercise and Sport. 2011;**82**(3):521-535

[96] Marshall J, Hardman K. The state and status of physical education in schools in international context. European Physical Education review. 2000;**36**(3):203-229. DOI: 10.1177/1356336X000063001