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Factors Affecting Sleep Quality among Adolescent Athletes

Hoi Man Lo[1,2], Joyce Hoi Yee Leung[1,3], Gavin Ka Yin Chau[4], Michael HS Lam[1,2,5]*, Ka Yiu Lee[1,2,5] and Alex Ho[1]

[1]*Vocational Training Council, Chai Wan, Hong Kong*
[2]*Academy of Sport and Physical Activity, Faculty of Health and Wellbeing, Sheffield Hallam University, UK*
[3]*Hong Kong Baptist University, Kowloon Tong, Hong Kong*
[4]*Faculty of International Tourism and Management, City University of Macau, Xian Xing Hai, Macau*
[5]*International Industry and Professional Accreditation Association, Hong Kong*

Abstract

Objectives: This study used a cross-sectional experimental design to examine the association between sleep quality and sports performance among adolescent recreation team-sports athletes in Hong Kong. By investigating the factors that affect sleep quality, it intended to arouse awareness of coaches and athletes the importance of sleeping so that they can improve training and competition performance.

Methods: Hundred and twelve male and female participants with age range from 12 to 17 were involved in this study. A One-way ANCOVA model was designed to analyze the relationships among sleep quality and five factors (consume of caffeine or alcohol, extreme mood, sleeping environment, anxiety due to academic, and anxiety due to sports) and multiple regression analysis was adopted to predict the sleep quality through the coefficient of those variables.

Results: Consumption of drinks or food that contained caffeine or alcohol, experiencing extreme mood such as shock or being too excited before sleep and having a bright and noisy sleeping environment affected the sleep quality. Most student athletes were struggling between academic results and sports in Hong Kong. The results had shown that nervousness due to academic was another factor that affected sleep quality. It has also found that not only academic results could affect sleep quality of student-athletes, but also nervousness due to sports could also be another thrilling factor. There were significance effects among factors in "drinking/eating drinks/food which contains caffeine or alcohol", "poor sleeping environment", "sleeping duration", and "self-rated sleep quality".

Conclusion: The preliminary findings provide evidence that majority of secondary student-athletes are suffering from inadequate sleep due to dreadful sleeping qualities, which caused adverse conditions both physically and psychologically, and brought worst impacts to training and competitions performance. It is recommended that sleep hygiene could be promoted to coaches and athletes to enrich their knowledge of having better sleeping patterns. Much needed evidence regarding relationships of different aspects such as brain wave, sleeping patterns, injuries, diet, and the possible effects on sleep quality.

Keywords: Sleeping; Sleep quality; Sleeping patterns; Adolescent student-athletes; Sports performance; Consume of caffeine or alcohol; Extreme mood; Sleeping environment; Anxiety; Academic

Introduction

Sleeping is the basic and indispensable components for post-exercise recovery and regeneration (PERR). It can influence the mental and physical functioning of human body directly. A healthy adult spends about one -third of his life for sleeping, it is the basic and essential human need [1]. Sleep is defined as a dynamic behavior, not simply the absence of waking, but a special activity of the brain, controlled by elaborate and precise mechanisms. It is not simply a state of rest but has its own specific, positive functions [2].

Necessity of sleeping varies from person to person, but it has closely related to age. According to Bethesda National Institutes of Health [3], sleeping needs change throughout the life cycle. Newborns sleep between 16 and 18 h a day, and children in preschool sleep between 11 and 12 h a day. School-aged children and adolescents need at least 10 h of sleep each night. Chung and Cheung [4] indicated that students of age 12-19 years old required 7.3 h of average sleeping every night. In general, people state they have sleeping problems such as hard to get to sleep, wake up in midnight, wake up early but cannot sleep again. In Hong Kong, studies found that adolescents felt tired in daytime, which indicated that sleeping problem was quite serious [5].

Kamdar et al. [6] stated that every human needs a specific amount of sleep to meet the daily homeostatic sleep requirement. Sleep plays an important role in human life, for example, physical and psychological restoration and recovery, conservation of energy, memory consolidation, discharge of emotions, brains growth and maintenance of immune system [7]. Studies reported that sleep quality and both physical and psychological condition have significant relationships in various areas. Physical conditions included cognitive processes, metabolic function, immune function, and appetite regulation while disruption of mood, decision-making and concentration were psychological conditions [8]. These conditions are interdependent and become a cycle as regular physical activity can improve sleep quality and good sleep quality enhances physical performance [9]. Therefore, adequate sleep can boost up athletes' performance and enhance learning. In addition, sleeping was also proved to be important for cognitive functioning

***Corresponding author:** Michael HS LAM, Academy of Sport and Physical Activity, Faculty of Health and Wellbeing, Sheffield Hallam, UK, Tel: +44 114 225 5560; E-mail: michaelhslam@vtc.edu.hk

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and implanting new memories [10]. While sleeping, newly formed memories were being organized in the brain resulting in better recall and accurate memory in the coming day. Problem solving abilities and concentration were being enriched as well [11].

Sleep quality includes sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The "Pittsburgh Sleep Quality Index" (PSQI) is the most common and reliable sleep quality questionnaire [12]. It assesses sleeping qualities and disturbances in a one-month interval. The total score of PSQI is from 0 to 21, the higher score, the poor sleep quality. Sleep disruptions have negative impacts on physical functioning and psychological functioning of human body. As sleep disruptions would affect the release of hormones, sense of hunger was aroused and caused over-eating [13]. Diet balance and body weight would be affected if athletes suffered from disrupted sleep for a long period. The immune system would correspondingly be compromised and become weak, more illnesses would be infected [7]. Moreover, bad sleep quality affected motor performance and increased risks of injuries. It negatively influenced the circadian rhythm directly, as well as increased fatigue, decreased reaction time, and decreased maximal oxygen uptake (VO_2max) [14,15]. Human who suffered from disrupted sleep have negative mood states like depression and decreased motivation, leading to psychological stress [14]. Previous studies indicated that negative mood directly affected athletes' performance [16]. Brain regulated emotional states were highly sensitive to the quality and quantity of sleep [17].

Sleep hygiene is a term used to describe a collection of behaviours related to the promotion of good sleep [18]. It is usually recommended that good habits and behaviours can enhance sleep quality and quantity. According to the Centre for Clinical Interventions (CCI), good sleeping hygiene such as avoiding consume of caffeine and nicotine, no naps, and sleep rituals can improve sleep quality. In a local study, Suen et al. [19] examined the awareness and knowledge of sleep hygiene among university students. They observed that sleep hygiene practice was significantly associated with sleep quality. Poor sleep hygiene practices led to a higher prevalence of insomnia and sleeping problems [18]. Based on the National Sleep Foundation [20], sleep hygiene promoted healthy sleep and daytime alertness. It can also prevent the development of sleep problems and disorders.

Sleeping is a major role of recovery, repair and physiological growth of athletes and it has great influence on sports performance. There are two main factors which affected sleep quality, namely intrinsic factors and extrinsic factors. Tension and stress are the main intrinsic reasons affecting sleep quality among college students [21]. Athletes were often affected by the pressure which come from family commitments, training, social life, and fulfil the demand of academic studies [22]. Worries and nervousness become major contributors to pre-sleep cognitive arousal, leading to interfere of sleep [23]. These aspects created anxieties and prolonged sleep latency, waking up early, and frequent awakenings during the night and restricted the quality of sleeping. These symptoms were defined as clinical primary insomnia [24]. Furthermore, it has been shown that mood and sleep have close relationship to each other. If the athlete has chronic training fatigue or being overtrained for a long period, he will experience low mood and depression, which would cause sleeping disturbance and insomnia [25]. In contrast, excitation will raise a person's arousal and cause the person hard to fall asleep [26].

Athletic performance is highly and directly depended on "sleep-wakefulness circadian cycle", one of the main human biological rhythms [27]. This rhythm made the human body feels awake in the morning and sleepy at night. Each athlete has own preferred sleeping schedule that suit his circadian. If the circadian phase and sleeping schedule are incompatible, the quantity and quality of sleep would be affected [25]. Sports performance tended to peak in the afternoon, between noon and 9 pm. when body temperature and muscle blood flow increased during the awake stage [28]. There was a higher level of effectiveness to execute some sensory and complex motor tasks during afternoon, thus aerobic performance would be optimal in the evening. In the morning, around 10 a.m., mental tasks, reaction time, and sustained attention to be reduced [27] and it was not the best time to perform complex motor skills, but it is when humans' alertness was at its highest level [28].

Extrinsic factors that would affect sleep quality and patterns include environment and consumption of caffeine and alcohol, and level of exercising. It has been shown that noises like snoring of bed partner or traffic would decrease the total sleep time and REM-sleep [29]. Extreme room temperatures also disrupted sleep in the environment [30]. Body temperature adjusted throughout the circadian rhythm under any extreme heat or cold at night, and it would disrupt the sleep quality. In 2010, Venter found out that over 40% of team-sport players have experienced difficulties in falling asleep and noise and illumination were the main extrinsic factors that influenced sleep quality.

Consumption of alcohol has both positive and negative influences on sleeping [31]. A study found that blood alcohol levels below 10 mg/dL might increase total sleep time and decrease awake activity. Conversely, more than 10 mg/dL will cause a decrease in REM-sleep [2]. Sierra et al. [32] found that consuming 2-4 alcoholic drinks daily caused poor sleep quality and greater sleep latency. Chronic ingestion of alcohol would also cause a loss of slow-wave sleep and disruption of sleep patterns [2]. Several studies have examined the consumption of caffeine have the negative impacts on sleep onset latency or other sleeping qualities [31]. Caffeine suppressed melatonin and maintained sleep hormone and irritation Epinephrine secretion [5]. Caffeine was considered as a mild central nervous system stimulant and was the most commonly used methylxanthine [33]. Bonnet and Arand [34] examined that with doses of 100 mg or greater caffeine before 2 h going to bed could increase sleep latency, decrease slow wave sleep, and decrease total sleep time. Sierra et al. [32] found that consuming 2 to 4 cups of coffee triggered poor sleep quality, more sleeping problems and greater sleep latency. However, the knowledge of which beverage contain caffeine is insufficient in Hong Kong.

Even student-athletes might require travelling to other countries for exchange training and competitions. Travel across time zones will lead the circadian rhythm shifted, and affecting sleeping patterns as well as athletic performance [7]. Jet Lag could cause an inability to sleep at local time, increased irritability, and caused moodiness and headaches [35]. In addition, as long travels usually caused tiredness to athletes, and it was difficult to eliminate sleep disturbances, and how to adjust the body clock are preferred.

Benefits of engaging in exercises are well known [36-51]. Exercising regularly can help increasing the total sleeping time and depth of sleep, as well as decreasing sleep onset latency [52]. On the other hand, exercising within 2-3 h before sleeping might delay sleep onset [53]. People who perform routine exercises, 30 min per day, 3 to 4 days a week could improve sleep duration, sleep onset latency, and quality of sleep. Routine exercises could improve cardiac function, reduce weight, and control blood pressure, lipids levels and reducing daytime sleepiness [54]. Individuals with high physical activity levels reported

less sleep disturbances. Yet, individuals with lower physical activity levels exhibited longer sleep [55].

For athletes, better sleep will better decision-making ability, higher the attention and speed of reaction time, and improve sports performance. A study showed that after increasing the sleeping time to 10 h per night for 5-7 weeks, basketball players had faster sprinting times, higher free throwing percentage, higher 3-point field goal percentage, faster reaction times, and decrease in daytime sleepiness [56]. If energy expenditure of athletes increased in daytime, the blood levels of growth hormone rise during the following night. But if the athletes lost slow-wave sleep, these levels fell significantly [27]. However, there is not much studies conducting about the relationships of sleep quality and sports performance among recreation athletes.

Adolescents require sleeping for growth. Sleeping allows the physiological processed and caused revitalization during slow wave sleep which facilitated by metabolic activity. Physiological revitalization hits its peak during slow-wave sleep while the body's metabolism is at its lowest. There is also a significant peak in the secretion of growth hormone [27]. The secretion of growth hormone will improve the endocrine system during this period [57]. More than 95% of the daily hormones production occurred during Non-Rapid Eye Movement-sleep (NREM-sleep), especially in the first cycle of slow-wave sleep [58], hence, sleep quality and quantity are important for the growth of adolescent.

This study aims to explore the factors that affecting sleep quality of adolescent student-athletes, and to arouse the awareness of athletes and coaches about the importance of sleeping. It is expected that with better understanding of sleeping, it can improve the training and competition performance of the Hong Kong student-athletes. This study intends to examine the association between sleep quality and sports performance among adolescent recreation athletes of team-sports in Hong Kong, and to evaluate the factors that influence sleep quality.

Materials and Methods

Participants

Hundred and twelve male and female participants were recruited from two local secondary schools. Team ballgame sports included basketball, football, volleyball and handball. The inclusion criteria included male and female students, aged 12-17 years old, participating in regular team ballgames training. The required recreation team athletes are selected by convenience sampling. The Sheffield Hallam University Research Ethical Committee approved this study. Written informed consent was obtained from each participant prior to data collection.

Procedures

This study used a cross-sectional descriptive design to examine sleep quality among adolescent team recreation athlete in Hong Kong. This study attempted to examine their sleep quality and evaluate the factors that influence sleep quality, which can improve their sports performance.

Invitations were sent to secondary school principals to get permission to conduct the study at their schools. Pilot test was adopted. Questionnaires were distributed to secondary school sports teams, including basketball, football, volleyball, and handball team members by student helpers through convenience sampling. The questionnaires were collected after three weeks.

Assessments

A One-way ANCOVA model was designed to analyze the relationships among sleep quality and five factors (consume of caffeine or alcohol, extreme mood, sleeping environment, anxiety due to academic, and anxiety due to sports) and multiple regression analysis was adopted to predict the sleep quality through the coefficient of those variables. A multiple regression analysis was used to precited the sleep quality through the coefficient of the variables.

Statistical analysis

Data were analyzed by the Statistical Package for the Social Sciences 24.0 (SPSS for Windows, IBM). Any responses that indicated a range of times were averaged for ease of analysis (e.g., 10-20 minutes was recorded as 15 minutes). These factors which affecting sleep quality (PSQI) like sleeping environment were analysis by one-way ANOVA. Also, multiple regression analysis was adopted to predict the sleep quality through the coefficient of those variables. Global PSQI score, mean, standard error was also used as descriptive analysis [59].

The respondents were required to answer how often they suffered from poor sleep quality or hard to sleep because of five different factors, namely "drinking/eating drinks/food which contain caffeine or alcohol", "experience extreme mood before sleep", "poor sleeping environment", "nervous/anxiety due to academic" and "nervous/anxiety due to sport". Four options were provided for respondents to choose, included "not during the past month", "less than once a week", and "once or twice a week", and "three or more times a week".

Results

A total of 112 participants involved in this study, including 53 males and 59 females. Respondents were aged 12-17 years old. The average sleeping duration was 6.402 ± 1.0566 h. 58.9% respondents slept less than 7 h a day. Average fell asleep time was at 23:26 and the average woke up time was 06: 33. The average sleeping latency is 13.63 ± 9.2 min. Within that range, 52.7% respondents could sleep within 1-10 min after they were in bed; 34.8% respondents slept within 11-20 min; 11.6% respondents slept within 21-30 min; only 0.9% required more than 30 min to getting into sleeping.

The mean of global PSQI score was 5.40 ± 3.613. The higher the scores represented the worser the sleep quality. A score of >5 was considered to be "bad" sleeper, while a score of < 5 was considered a "good" sleeper [60]. Results have shown that about 72.3% respondents had poor sleep quality.

58% respondents rated their sleep quality as "fairly good" and "very good". 47% rated as "fairly bad" and "very bad". None of them required to have medication to assist in sleeping in the past month. 42% respondents were hard to maintain their motivation on studying or working.

By using one-way ANOVA, it was illustrated that consume of drinks or food that contained caffeine or alcohol before sleeping did affect the sleep quality ($p<0.001$). Experiencing extreme mood such as shock or being too excited before sleeping affected the sleep quality ($p<0.05$). Noisy or having a bright sleeping environment have a significant effect on sleep quality as well ($p<0.001$). Most student athletes were struggling between academic results and sports in Hong Kong. The results had shown that nervousness due to academic was another factor that affected sleep quality ($p<0.01$). It has also found that not only academic results could affect sleep quality of student-athletes, but also nervousness due to sports could also be another thrilling factor ($p<0.001$).

A multiple regression analysis was used to predict the sleep quality through the coefficient of the variables. There were significance effects among factors in "drinking/eating drinks/food which contains caffeine or alcohol", "poor sleeping environment", "sleeping duration", and "self-rated sleep quality".

Discussion

These findings provide useful information about the association between sleep quality and sports performance among adolescent recreation team sports athletes in Hong Kong. Factors that influence sleep quality are also evaluated. As expected, better sleep quality has positive effects on athletes' performance such as better decision-making, higher attention and speed of reaction time [56]. The study intended to examine student-athletes' general sleeping pattern and the factors that affect sleep quality. PSQI was adopted to measure sleep quality and it is shown that over 70% student-athletes are suffering from poor sleep quality. Factors such as consume of contain caffeine or alcohol, sleeping environment, and stress and anxiety affect sleep quality most significantly [7,22,31].

Sleeping problems is getting more severe in Hong Kong [4,5], especially for student-athletes in secondary schools as they have heavy burdens in both academic and sports and cannot get a balance between the two. School-aged children and adolescents require having about 10 h of sleeping every night for healthy body development [3]. However, respondents of this study are suffering from insufficient sleep with average sleep duration of 6.4 h a day only and 58.9% respondents are having less than 7 h of sleep a day.

Mean PSQI score of sleep quality is around 5 globally. The higher score, the worser the sleep quality. A score that higher than 5 is considered as "bad" sleeper" while lesser than 5 is considered as "good" sleeper [12,60]. Mean score of respondents in this study was 5.4 which indicated they were experiencing poor sleep quality and having moderate difficulties in sleeping. Almost half of the respondents described their sleep quality as "fairly bad" and "very bad" which showed that they were not satisfied with their sleep quality. None of them required to have medication to assist in sleeping in the past month. People without sleeping disorder can fall asleep in 10 to 20 min [12] and in average, respondents could sleep around 14 min after they were in bed. It indicated that respondents in this study did not have problems in delayed sleep onset.

It was presumed that factors, namely "drinking/eating drinks/food which contain caffeine or alcohol", "experience extreme mood before sleep", "poor sleeping environment", "nervous/anxiety due to academic" and "nervous/anxiety due to sport" would affect the sleep quality in this study.

Consume of caffeine or alcohol before going to bed would affect sleep quality, which would lead to decrease in sleep latency, and longer sleep onset latency [2,32] as caffeine or alcohol would shorten REM sleep (deep sleep) and prolong non-REM (light sleep) and directly impact the sleep quality.

Mood can strongly affect sleeping and it was found in previous studies that poor sleep quality was associated with significantly higher self-reported negative moods [21]. Sleep-deprived individuals suffered from extreme mood before sleep also reported that they consistently experiencing depression, stress, anxiety, worries, frustration, irritability, and having lower confidence [7]. In this study, respondents experienced extreme mood such as shock and depression before sleeping, did affect the sleep quality and it also caused sleeping disturbance and insomnia. However, the prediction of experiencing extreme mood before sleeping was low, which indicated that sleep quality was not affected by this factor.

Sleeping can be directly affected by the surrounding, and lighting, noise, room temperature are the main influences that disturbed sleep [29,30]. In Venter's studies [7], it is found that noise and lighting were the main aspects that caused team-sports players experiencing problems in falling to sleep. In this study, poor sleeping environment has significant acute impacts on sleep quality. The prediction of poor sleeping environment to make sleep quality worser was significantly high which indicated person sleeping in poor environment was more likely to suffer from distressing sleep quality.

Some main reasons for poor sleep quality of university students were found to be bad academic results, doing assignments after 8 pm at night, and high academic stress [61]. In the study conducted by Bompa and Haff [22] also found that pressure from family commitments, training, social life, and catch up with demand of academic studies could affect sleep quality. However, these aspects were unable to predict influences in sleep quality in this study.

Sleep hygiene is a term used to describe a collection of behaviors related to the promotion of good sleep [18], yet has always been ignored. In a study [60], it was indicated that student-athletes of team sports had high median scores in global sleep quality due to anxiety in sports. Worry and anxiety were also major contributors to pre-sleeping cognitive arousal that interfered sleeping [23]. Compare to anxiety due to academic, anxiety due to sports appeared to be more influential but this factor did not have significant prediction to sleep quality.

There are several limitations in this study. This study focused on students of two secondary schools in Hong Kong, which limits the generalization of results. Short questionnaire was used to assess factors that affect students' sleep quality before the season when the Hong Kong Diploma of Secondary Education Examination were held. Findings may be limited due to self-reporting and respondents may potentially susceptible to pressure and bias. It is important to include objective measurements [62-67]. Sleep monitor machine would help measuring the sleep quality to increase reliability and accuracy of the preliminary findings and add further insight into the sleeping patterns among student-athletes of secondary schools. Statistical analyses were not sophisticated [68,69] which may limit the findings [70].

Conclusions

The preliminary findings provide evidence that majority of student-athletes in secondary schools who suffered from inadequate sleep due to dreadful sleeping qualities and lead to worst impacts to training and competitions performance. The analysis indicated major effects on sleep quality and this study provided a foundation and understanding towards sleep hygiene and habits. It is recommended that coaches and athletes to be educated that sleeping can influence their academic and sports performance. Sleep hygiene can also be promoted to enrich their knowledge of having better sleeping patterns. Further research to determine relationships of different aspects such as brain wave, sleeping patterns, injuries, diet, and the possible effects on sleep quality is warranted in this population.

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