

## Prevalence of Sedentary Behaviors and Sleep Duration among Saudi Soccer Players

Mohammad Ali Alahmadi, Khalid Hamdan Almasoud

Department Physical Education and Sport Sciences, Taibah University, Saudi Arabia  
[doctoralahmadi@gmail.com](mailto:doctoralahmadi@gmail.com), [khalmasoud@gmail.com](mailto:khalmasoud@gmail.com)

### Abstract

*The purpose of this study was to evaluate sedentary behavior (SB) among Saudi soccer players. Ninety-six soccer players (age  $17.0 \pm 1.0$  years; body mass,  $60.5 \pm 9.3$  kg; height,  $168.0 \pm 6.6$  cm) participated in this study. A self-reported questionnaire was used to assess SB (time spent watching television, Electronic games, and internet use). The mean total screen time among the soccer players was 304.6 min/day. Seventy-nine per cent of soccer players spent  $> 2$  h/day in screened-based SB. Use of electronic games use was the predominant SB among soccer players ( $128.4 \pm 114.9$  min/day), followed by time spent watching TV ( $114.3 \pm 92.2$  min/day). Average sleep duration of soccer players during weekdays and weekends were  $7.3 \pm 1.4$  and  $7.7 \pm 1.6$  h/night, respectively. Approximately 27% of soccer players had insufficient sleep ( $< 7$  h/night) during the week and 20% of them had insufficient sleep at the weekends. SB was evident in this group of Saudi soccer players, and more than a quarter of studied soccer players had insufficient sleep. The effect of prolonged SB and insufficient sleep duration may impair health and the performance of soccer players.*

### Introduction:

Physical inactivity is a major risk factor for a variety of diseases such as coronary heart disease, type 2 diabetes, and breast and colon cancers (Lee et al. 2012). In addition to physical inactivity, sedentary behavior (SB) is linked to adverse cardiometabolic risk profiles and premature mortality (Löllgen, Böckenhoff and Knapp 2009; Warren et al. 2010). SB has unique determinants and health consequences: multiple studies have shown that physical inactivity and SB are two independent entities (Chomistek et al. 2013; Janssen and Ross 2012; Tremblay et al. 2017; Young et al. 2016). Therefore, it is evident that SB differs from not doing physical activity or not meeting recommended levels of daily physical activity of moderate to high intensity (Hamilton et al. 2008; Tremblay et al. 2010).

Research has suggested that individuals can simultaneously exhibit both high levels of physical activity as well as high levels of SB (Tremblay et al. 2010). Highly trained athletes who compete in physically demanding sports clearly meet the recommended levels of daily physical activity to achieve health benefits. Although SB could affect health and performance in these athletes, there has been very little research on SB in this population. According to a new review article, there are only a few studies on the prevalence of SB among athletes, which demonstrated that a considerable amount of time was spent in SB (from 4.5 to 12.3 h/day) (Izzicupo et al. 2019). Therefore, there is clear evidence to suggest that SB still exists in highly trained elite athletic individuals. Since SB occurs frequently in daily life, more attention should be paid to its prevalence with respect to elite athletes. Only two studies have so far investigated SB of soccer players (Exel et al. 2019; Weiler et al. 2015), and found that soccer players spent a considerable amount of time in sedentary activities (8–9 h/day).

Furthermore, the relationship between sedentary activities and sleep duration has recently received a lot of attention (Aadahl et al. 2013; Alahmadi 2021a; Bromley et al. 2012; Chahal et al. 2013; Watenpaugh 2009). Recent evidence suggests that SB increases the risk of insomnia and sleep disturbances (Yang et al. 2017). According to the findings from a recent study, both screen-time SB and overall sedentary activity are linked to short ( $< 7$  h) and long ( $> 9$  h) sleep duration (Štefan, Horvatin and Baić 2019). Insufficient sleep duration and quality may also negatively affect athletic performance (Mah et al. 2011).

Although SB and its various forms have been assessed and identified among the general

population in Saudi Arabia, SB among highly trained elite athletes has not been investigated. There is only one study to date that documents SB and its types, as well as sleep duration among Saudi basketball players (Alahmadi 2021b). Therefore, it is important to determine the prevalence of SB among Saudi elite soccer players. Consequently, the current study aimed to assess the prevalence of SB among Saudi elite soccer players and to determine the predominate types of SB among this population. A secondary aim of this study was to estimate sleep duration of Saudi elite soccer players during weekdays and weekends.

## Methodology

### Participants and Study Procedure

Ninety-six soccer players (age,  $17.0 \pm 1.0$  years; body mass,  $60.5 \pm 9.3$  kg; height,  $168.0 \pm 6.6$  cm) were selected from two Saudi Professional League clubs (Al-Shabab Football Club and Al Hilal Football Club) in Riyadh, Saudi Arabia, to participate in this study. All soccer players were registered in the Saudi Football league system. The study protocol and procedures conformed to International Ethical Guidelines, and all participants were made to sign an informed consent form.

### SB and Sleep Duration Assessments

A self-report SB questionnaire was used to determine the amount of time participants spent in sedentary activities as well as their sleep duration. The questionnaire has previously been demonstrated to be valid and reliable for assessing sedentary activities (Al-Hazzaa and Al-Ahmadi 2003; Al-Hazzaa HM 2011). Time spent watching television (TV), playing electronic games, using a computer, and surfing the internet were all included as sedentary activities. Total sedentary time was also taken into account, calculated and expressed in minutes per day. A two-hour cut-off point was used for defining SB, according to the recommendations of the American Academy of Pediatrics (AAP), which suggests limiting the total screen time of youths to 2 h/day (AAP 2001). A seven-hours per day was used as a cut-off point for sitting time (Chau et al. 2013). Therefore, the total reported SB per day was divided into two categories: participants who reported  $\geq 7$  h/day ( $\geq 420$  min/day) were defined as being highly sedentary, whereas those who reported a sitting time of  $< 7$  h/day ( $< 420$  min/day) were defined as being less sedentary.

This study also used self-reported sleep duration to estimate the number of hours spent sleeping at night through two questions: “How many hours, approximately, do you usually sleep during a workday/weekday night?” and “How many hours, approximately, do you usually sleep per night during a weekend?” The response alternatives were  $\leq 3$ , 4, 5, 6, 7, 8, 9, or  $\geq 10$  h. Sleep durations less than 7 hours per night were defined as inadequate (St-Onge et al. 2016).

## Results

Table 1 presents the mean  $\pm$  SD of the characteristics and sedentary behavior of soccer players. The total amount of time soccer players spent in sedentary behaviors was  $304.6 \pm 190.3$  min/day. Playing electronic games was the most predominant sedentary behavior ( $128.4 \pm 114.9$  min/day) among soccer players. Table 2 shows that the majority of soccer players sat for more than two hours per day (71.1%), while 79.2% of soccer players spent more than seven hours per day in sedentary behaviors (Table 2). Moreover, Table 3 presents the mean and percentage of sleep duration throughout weekdays and weekends.

Table 1: Characteristics and Sedentary Behavior of Saudi Soccer Players

Variables	Results
Age (years)	$17.1 \pm 1.0$
Weight (kg)	$60.5 \pm 9.3$
Height (cm)	$168.0 \pm 6.6$

BMI (kg/m <sup>2</sup> )	21.3 ± 2.4
Watching TV (min/day)	114.3 ± 92.0
Electronic games playing (min/day)	128.4 ± 114.9
Internet use (min/day)	61.8 ± 62.5
Total sedentary time (min/day)	304.6 ± 190.3

BMI, body mass index

Table 2: Percentage of Soccer Players Engaged in Sedentary Behavior, Based on Two Different Cut-off Points

Variables	Results
Sitting time ≥ 2 h/day (%)	71.1
Sitting time < 2h/day (%)	22.9
Sitting time ≥ 7 h/day (%)	79.2
Sitting time < 7 h/day (%)	20.8

Table 3: Mean and percentage of sleep duration during weekdays and weekends among Saudi soccer players

Variables	Sleep Duration	
	Weekdays	Weekends
Sleep duration (h/day)	7.3 ± 1.4	7.7 ± 1.6
Sleep duration < 7 h (%)	27.1	20
Sleep duration ≥ 7 h (%)	72.9	80

## Discussion

This study identified that SB was prevalent among Saudi elite soccer players. Furthermore, more than a quarter of Saudi elite soccer players had insufficient sleep during the week. To the best of our knowledge, this is the first study showing that SB exists in Saudi elite soccer players. It also reveals that soccer players are not free from the high risk of prolonged sitting. The majority of Saudi elite soccer players (71.1%) in this study do not meet the SB recommendations with respect to daily screen time. To date, there are only two studies that have determined the prevalence of SB among soccer players (Exel et al. 2019; Weiler et al. 2015). Weiler et al. (2015) showed that the majority of soccer players (79%) were sedentary in their leisure time, spending approximately 8 h/day in sedentary activities (Weiler et al. 2015). Similar results were found by Exel et al. (2019), who identified that soccer players spent a considerable amount of time in sedentary activities (9 h/day) (Exel et al. 2019). In Saudi Arabia, only one similar study has been conducted, which found that the average amount of time basketball players spent in SB was 7.5 h/day, and 93.7% of basketball players spent greater than 2 h/day in sedentary activities (Alahmadi 2021b).

Although SB is particularly common in daily life, less attention has been paid to its prevalence in elite athletes; therefore, there are few studies that have addressed this issue. Elite rowers have been found to display sedentary off-training behavior, spending more than 11.5 h/day in SB (Sperlich et al. 2017). Another study conducted on marathon and half-marathon participants showed that their total sitting time was more than 10 h/day (Whitfield, Pettee Gabriel Kk Fau - Kohl and Kohl 2014). The total SB of elite male athletes from different disciplines was 7.70 h/day (Júdice et al. 2014). There is strong evidence for considering SB as a health risk factor, independent of physical activity time (Koster et al. 2012; Owen et al. 2010; Proper et al. 2011; Thorp et al. 2011; Tremblay et al. 2010). Increased mortality risk was found to be linked to a daily sitting time of more than 7 h/day, as was shown by a meta-analysis of the relationship between daily sitting time and all-cause mortality (Chau et al. 2013). Another meta-analysis based on 13 studies found an greater risk of all-cause mortality in adults who spent four or more hours per day in SB (Ekelund et al. 2016). Concerns regarding the duration of time

engaged in sedentary activities have already been raised, leading to the current guidelines and recommendation that screen time should be limited to less than 2 h/day (AAP 2001). SB, which is generally described as screen-based media usage behaviors such as watching TV, using computers/smartphones, and playing video games (Iannotti et al. 2009), has been linked to a variety of poor health outcomes (Biddle, García Bengoechea and Wiesner 2017; Leung et al. 2012; Li et al. 2021; Schmid et al. 2021; Wu et al. 2017). It is interesting to note that playing electronic games is the predominant SB (2.2 h/day) among Saudi elite soccer players, followed by TV viewing (1.9 h/day), and computer/internet use (1.03 h/day). In previous studies, TV viewing has been identified as the predominant SB and has been used to measure this behavior (Stamatakis et al. 2019). There is also substantial evidence suggesting that there are adverse associations between TV viewing time and a variety of cardiovascular risk factors. A few of these factors include metabolic syndromes and obesity, abnormal glucose metabolism, and type 2 diabetes (Dunstan et al. 2007; Dunstan et al. 2005; Fb et al. 2003; Wijndaele et al. 2007). Furthermore, cross-sectional studies of both adults and children have revealed that TV viewing time was the major leisure-time SB that has a detrimental impact on obesity (Owen et al. 2000). In one cross-sectional study, TV viewing time was also linked to cardio-metabolic biomarkers in an Asian population, in contrast to computer use or reading time. (Nang et al. 2013). The current study shows that soccer players spent less time watching TV and that this was not the most common sedentary activity. This finding, regarding the most common type of SB, was similar to the outcome of an earlier Saudi study of SB (Alahmadi 2021b), in which computer/internet use was found to be the predominant SB among basketball players (191.8 min/day), followed by electronic game playing (186.2 min/day). Thus, it seems that TV viewing time is not the predominant leisure-time SB among elite athletes compared with different population, such as children (Schmid et al. 2021; Tahir, Willett and Forman 2019) and male and female adults (Cao et al. 2019; Ikehara et al. 2015; Stamatakis, Hamer and Mishra 2012).

In addition to SB, sleep is an important aspect of the athletic population. There is strong evidence supporting the importance of sleep for competitive athletes in order to achieve high performance (Kirschen, Jones and Hale 2020): insufficient sleep duration and quality may have harmful effects on athletic performance (Mah et al. 2011). Previous studies have reported that elite athletes' sleep duration is 6.5–6.8 (h/night), which does not meet the traditional 8 h recommendation (Lastella et al. 2015; Leeder et al. 2012). A recent study found that most professional soccer players (68.5%) suffer from a sleep disorder (Karim et al. 2019). In the Middle East, soccer players did not obtain sufficient sleep durations (6.3–7.3 h/night), relative to the National Sleep Foundation guidelines (Fowler et al. 2017). In our study, the sleep duration of Saudi soccer players during weekdays and weekends was 7.3 and 7.7 (h/night), respectively. Approximately 27% of soccer players had insufficient sleep (< 7 h/night) during weekdays, and similar number (20%) had insufficient sleep during weekends. Our previous work found similar results, where Saudi basketball players had insufficient sleep (< 7 h/night) during weekdays (25%) and weekends (12.5%) (Alahmadi 2021b).

Although soccer players are more likely to sleep for longer than non-athletes, which might be because of an earlier bedtime (Thomas et al. 2021), they tend to sleep more on the weekends. This indicates that long weekend sleep may be used to compensate for short weekday sleep (Åkerstedt et al. 2019). Weekend compensatory sleep has been found in obese children (Wing et al. 2009) and hypertensive adults (Hwangbo et al. 2013). Sleeping more on the weekend to compensate for weekday sleep deficits could increase the risk of hypertension in adults and the risk of childhood obesity. With respect to athletes, total sleep time during

weekends was longer than that of weekdays, which has been shown to negatively impact student-athletes' psychomotor performance due to sleep debt (Suppiah, Low and Chia 2016). In adolescent student-athletes, an accumulation in decreased sleep time on weekdays throughout the week was linked to a worsening of reaction times by the end of the week (Suppiah, Low and Chia 2016).

Over the last few centuries, there has been a decline in both average sleep duration and quality, resulting in adverse consequences on general health (Chang et al. 2015). Light has a significant impact on sleep and it is highly likely that elite athletes use electronic media devices to communicate before and after an event/match, thereby preventing good sleep hygiene (Nédélec et al. 2015). Furthermore, light-emitting devices have been found to disrupt sleep and affect next-morning alertness (Chang et al. 2015). A recent study reported that the majority of elite athletes (70%) engaged in sedentary (blue-light emitting) activities within an hour before bedtime (Knufinke et al. 2018). A study conducted in Chinese female basketball players to determine the effect of red light on sleep quality and endurance performance found there was an improvement in sleep, melatonin and endurance performances following a 14-day whole-body irradiation with red-light (Zhao et al. 2012). Therefore, elite soccer players are recommended to practice sleep hygiene procedures to maintain the natural light-dark cycle and avoid cycle disruption (Nédélec et al. 2015).

### Conclusion

The majority of the soccer players spent a significant amount of time in SB, indicating that SB still exists in highly trained athletes, such as elite soccer players. The main type of SB was electronic game playing, followed by computer/internet use. More than a quarter of soccer players had insufficient sleep duration over the weekdays. The combined effects of prolonged SB and insufficient sleep duration may impair the health and performance of soccer players.

### References

- Aadahl, M., A. H. Andreasen, L. Hammer-Helmich, L. Buhelt, T. Jørgensen, and C. Glümer. 2013. "Recent temporal trends in sleep duration, domain-specific sedentary behaviour and physical activity. A survey among 25-79-year-old Danish adults." *Scand J Public Health* 41(7):706-11.
- AAP. 2001. "American Academy of Pediatrics. Committee on Public Education. American Academy of Pediatrics: children, adolescents, and television." *Pediatrics* 107:423-26.
- Åkerstedt, T., F. Ghilotti, A. Grotta, H. Zhao, H. O. Adami, Y. Trolle-Lagerros, and R. Bellocco. 2019. "Sleep duration and mortality - Does weekend sleep matter?" *J Sleep Res* 28(1):e12712.
- Al-Hazzaa, HM, and MA Al-Ahmadi. 2003. "self-reported questionnaire for the assessment of physical activity in youth 15-25 years: Development, reliability and construct validity." *Arab J Food Nutr* 4:279-91.
- Al-Hazzaa HM, Al-Sobayel HI, Musaiger AO. 2011. "Convergent validity of the Arab teens lifestyle study (ATLS) physical activity questionnaire." *International journal of environmental research and public health* 8(38):10-20.
- Alahmadi, MA. 2021a. "Health-Related Physical Fitness Components in Saudi Female Physical Education and Sport Sciences University Students." *EC Nutrition* 16(4):39-47.
- . 2021b. "Sedentary Behaviour and Sleeping Duration among Saudi Basketball Players." *Journal of Theories and Applications of Physical Education Sport Sciences* 4(1):31-45.
- Biddle, S. J., E. García Bengoechea, and G. Wiesner. 2017. "Sedentary behaviour and adiposity in youth: a systematic review of reviews and analysis of causality." *Int J Behav Nutr Phys*

- Act* 14(1):43.
- Bromley, L. E., J. N. Booth, 3rd, J. M. Kilkus, J. G. Imperial, and P. D. Penev. 2012. "Sleep restriction decreases the physical activity of adults at risk for type 2 diabetes." *Sleep* 35(7):977-84.
- Cao, J., E. S. Eshak, K. Liu, I. Muraki, R. Cui, H. Iso, and A. Tamakoshi. 2019. "Television Viewing Time and Breast Cancer Incidence for Japanese Premenopausal and Postmenopausal Women: The JACC Study." *Cancer Res Treat* 51(4):1509-17.
- Chahal, H., C. Fung, S. Kuhle, and P. J. Veugelers. 2013. "Availability and night-time use of electronic entertainment and communication devices are associated with short sleep duration and obesity among Canadian children." *Pediatr Obes* 8(1):42-51.
- Chang, A. M., D. Aeschbach, J. F. Duffy, and C. A. Czeisler. 2015. "Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness." *Proc Natl Acad Sci U S A* 112(4):1232-7.
- Chau, Josephine Y., Anne C. Grunseit, Tien Chey, Emmanuel Stamatakis, Wendy J. Brown, Charles E. Matthews, Adrian E. Bauman, and Hidde P. van der Ploeg. 2013. "Daily sitting time and all-cause mortality: a meta-analysis." *PLoS One* 8(11):e80000-e00.
- Chomistek, A. K., J. E. Manson, M. L. Stefanick, B. Lu, M. Sands-Lincoln, S. B. Going, L. Garcia, M. A. Allison, S. T. Sims, M. J. LaMonte, K. C. Johnson, and C. B. Eaton. 2013. "Relationship of sedentary behavior and physical activity to incident cardiovascular disease: results from the Women's Health Initiative." *J Am Coll Cardiol* 61(23):2346-54.
- Dunstan, D., Jo Salmon, Genevieve Healy, Jonathan Shaw, Damien Jolley, Paul Zimmet, and Neville Owen. 2007. "Association of television viewing with fasting and 2-h postchallenge plasma glucose levels in adults without diagnosed diabetes."
- Dunstan, D., Jo Salmon, Neville Owen, T. Armstrong, P. Zimmet, T. A. Welborn, Adrian Cameron, T. Dwyer, D. Jolley, and Jonathan Shaw. 2005. "Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults." *Diabetologia* 48:2254-61.
- Ekelund, Ulf, Jostein Steene-Johannessen, Wendy J. Brown, Morten Wang Fagerland, Neville Owen, Kenneth E. Powell, Adrian Bauman, and I. Min Lee. 2016. "Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women." *The Lancet* 388(10051):1302-10.
- Exel, Juliana, Nuno Mateus, Catarina Abrantes, Nuno Leite, and Jaime Sampaio. 2019. "Physical activity and sedentary behavior in amateur sports: master athletes are not free from prolonged sedentary time." *Sport Sciences for Health*:1-7.
- Fb, Hu, Li Ty, Graham Colditz, Willett Wc, and Manson Je. 2003. "Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women." *JAMA* 289:1758-91.
- Fowler, P. M., D. J. Paul, G. Tomazoli, A. Farooq, R. Akenhead, and L. Taylor. 2017. "Evidence of sub-optimal sleep in adolescent Middle Eastern academy soccer players which is exacerbated by sleep intermission proximal to dawn." *Eur J Sport Sci* 17(9):1110-18.
- Hamilton, Marc T., Genevieve N. Healy, David W. Dunstan, Theodore W. Zderic, and Neville Owen. 2008. "Too Little Exercise and Too Much Sitting: Inactivity Physiology and the Need for New Recommendations on Sedentary Behavior." *Current cardiovascular risk reports* 2(4):292-98.

- Hwangbo, Y., W. J. Kim, M. K. Chu, C. H. Yun, and K. I. Yang. 2013. "Association between weekend catch-up sleep duration and hypertension in Korean adults." *Sleep Med* 14(6):549-54.
- Iannotti, R. J., M. D. Kogan, I. Janssen, and W. F. Boyce. 2009. "Patterns of adolescent physical activity, screen-based media use, and positive and negative health indicators in the U.S. and Canada." *J Adolesc Health* 44(5):493-9.
- Ikehara, S., H. Iso, Y. Wada, N. Tanabe, Y. Watanabe, S. Kikuchi, and A. Tamakoshi. 2015. "Television viewing time and mortality from stroke and coronary artery disease among Japanese men and women -- the Japan Collaborative Cohort Study." *Circ J* 79(11):2389-95.
- Izzicupo, Pascal, Angela Di Baldassarre, Barbara Ghinassi, Felipe Fossati Reichert, Eduardo Kokubun, and Fábio Yuzo Nakamura. 2019. "Can Off-Training Physical Behaviors Influence Recovery in Athletes? A Scoping Review." *Frontiers in Physiology* 10(448).
- Janssen, I., and R. Ross. 2012. "Vigorous intensity physical activity is related to the metabolic syndrome independent of the physical activity dose." *Int J Epidemiol* 41(4):1132-40.
- Júdice, P. B., João P. Silva Am Fau - Magalhães, Catarina N. Magalhães Jp Fau - Matias, Luís B. Matias Cn Fau - Sardinha, and L. B. Sardinha. 2014. "Sedentary behaviour and adiposity in elite athletes." *J Sports Sci* 19(32):1760-67.
- Karim, Khalladi, Abdulaziz Farooq, Sofiane Souissi, Christopher P. Herrera, Karim Chamari, Lee Taylor, and F. Elmassioui. 2019. "Inter-relationship between sleep quality, insomnia and sleep disorders in professional soccer players." *BMJ Open Sport & Exercise Medicine* 5:e000498.
- Kirschen, Gregory W., Jason J. Jones, and Lauren Hale. 2020. "The Impact of Sleep Duration on Performance Among Competitive Athletes: A Systematic Literature Review." *Clinical Journal of Sport Medicine* 30(5):503-12.
- Knufinke, M., A. Nieuwenhuys, S. A. E. Geurts, A. M. L. Coenen, and M. A. J. Kompier. 2018. "Self-reported sleep quantity, quality and sleep hygiene in elite athletes." *J Sleep Res* 27(1):78-85.
- Koster, A., Kushang V. Caserotti P Fau - Patel, Charles E. Patel Kv Fau - Matthews, David Matthews Ce Fau - Berrigan, Dane R. Berrigan D Fau - Van Domelen, Robert J. Van Domelen Dr Fau - Brychta, Kong Y. Brychta Rj Fau - Chen, Tamara B. Chen Ky Fau - Harris, and T. B. Harris. 2012. "Association of sedentary time with mortality independent of moderate to vigorous physical activity." *PLoS One* 7(6):e37696.
- Lastella, M., G. D. Roach, S. L. Halson, and C. Sargent. 2015. "Sleep/wake behaviours of elite athletes from individual and team sports." *Eur J Sport Sci* 15(2):94-100.
- Lee, I. M., E. J. Shiroma, F. Lobelo, P. Puska, S. N. Blair, and P. T. Katzmarzyk. 2012. "Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy." *Lancet (London, England)* 380(9838):219-29.
- Leeder, J., M. Glaister, K. Pizzoferro, J. Dawson, and C. Pedlar. 2012. "Sleep duration and quality in elite athletes measured using wristwatch actigraphy." *J Sports Sci* 30(6):541-5.
- Leung, M. M., A. Agaronov, K. Grytsenko, and M. C. Yeh. 2012. "Intervening to Reduce Sedentary Behaviors and Childhood Obesity among School-Age Youth: A Systematic Review of Randomized Trials." *J Obes* 2012:685430.
- Li, Y., E. S. Eshak, R. Cui, K. Shirai, K. Liu, H. Iso, S. Ikehara, A. Tamakoshi, and S. Ukawa. 2021. "Television Viewing Time and the Risk of Colorectal Cancer Mortality among Japanese Population: The JACC Study." *Cancer Res Treat* 53(2):497-505.

- Löllgen, H., A. Böckenhoff, and G. Knapp. 2009. "Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories." *International journal of sports medicine* 30(3):213-24.
- Mah, Cheri D., Kenneth E. Mah, Eric J. Kezirian, and William C. Dement. 2011. "The effects of sleep extension on the athletic performance of collegiate basketball players." *Sleep* 34(7):943-50.
- Nang, Ei, Agus Salim, Yi Wu, E. Shyong Tai, Jeannette Lee, and Rob van Dam. 2013. "Television screen time, but not computer use and reading time, is associated with cardio-metabolic biomarkers in a multiethnic Asian population: A cross-sectional study." *The international journal of behavioral nutrition and physical activity* 10:70.
- Nédélec, M., S. Halson, B. Delecroix, A. E. Abaidia, S. Ahmaidi, and G. Dupont. 2015. "Sleep Hygiene and Recovery Strategies in Elite Soccer Players." *Sports Med* 45(11):1547-59.
- Owen, N., Charles E. Healy, Gn Fau - Matthews, David W. Matthews Ce Fau - Dunstan, and D. W. Dunstan. 2010. "Too much sitting: the population health science of sedentary behavior." *Exerc Sport Sci Rev* 38(3):105-13.
- Owen, Neville, Eva Leslie, Jo Salmon, and Michael Fotheringham. 2000. "Environmental determinants of physical activity and sedentary behavior." *Exercise and sport sciences reviews* 28:153-8.
- Proper, K. I., Willem Singh As Fau - van Mechelen, Mai J. M. van Mechelen W Fau - Chinapaw, and M. J. Chinapaw. 2011. "Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies." *Am J Prev Med* 40(2)(1873-2607 (Electronic)):174-82.
- Schmid, D., W. C. Willett, M. R. Forman, M. Ding, and K. B. Michels. 2021. "TV viewing during childhood and adult type 2 diabetes mellitus." *Sci Rep* 11(1):5157.
- Sperlich, B., M. Becker, A. Hotho, B. Wallmann-Sperlich, M. Sareban, K. Winkert, J. M. Steinacker, and G. Treff. 2017. "Sedentary Behavior among National Elite Rowers during Off-Training-A Pilot Study." *Front Physiol* 8:655.
- St-Onge, M. P., M. A. Grandner, D. Brown, M. B. Conroy, G. Jean-Louis, M. Coons, and D. L. Bhatt. 2016. "Sleep Duration and Quality: Impact on Lifestyle Behaviors and Cardiometabolic Health: A Scientific Statement From the American Heart Association." *Circulation* 134(18):e367-e86.
- Stamatakis, E., M. Hamer, and G. D. Mishra. 2012. "Early adulthood television viewing and cardiometabolic risk profiles in early middle age: results from a population, prospective cohort study." *Diabetologia* 55(2):311-20.
- Stamatakis, Emmanuel, Ulf Ekelund, Ding Ding, Mark Hamer, Adrian E. Bauman, and I. Min Lee. 2019. "Is the time right for quantitative public health guidelines on sitting? A narrative review of sedentary behaviour research paradigms and findings." *British Journal of Sports Medicine* 53(6):377.
- Štefan, L., M. Horvatin, and M. Baić. 2019. "Are Sedentary Behaviors Associated with Sleep Duration? A Cross-Sectional Case from Croatia." *International journal of environmental research and public health* 16(2).
- Suppiah, H. T., C. Y. Low, and M. Chia. 2016. "Effects of Sport-Specific Training Intensity on Sleep Patterns and Psychomotor Performance in Adolescent Athletes." *Pediatr Exerc Sci* 28(4):588-95.
- Tahir, M. J., W. Willett, and M. R. Forman. 2019. "The Association of Television Viewing in Childhood With Overweight and Obesity Throughout the Life Course." *Am J Epidemiol*



188(2):282-93.

- Thomas, C., H. Jones, C. Whitworth-Turner, and J. Louis. 2021. "A Sleep Analysis of Elite Female Soccer Players During a Competition Week." *Int J Sports Physiol Perform*:1-7.
- Thorp, A. A., Maïke Owen N Fau - Neuhaus, David W. Neuhaus M Fau - Dunstan, and D. W. Dunstan. 2011. "Sedentary behaviors and subsequent health outcomes in adults a systematic review of longitudinal studies, 1996-2011." *Am J Prev Med*. 41(2)(1873-2607 (Electronic)):207-15.
- Tremblay, M. S., S. Aubert, J. D. Barnes, T. J. Saunders, V. Carson, A. E. Latimer-Cheung, S. F. M. Chastin, T. M. Altenburg, and M. J. M. Chinapaw. 2017. "Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project process and outcome." *Int J Behav Nutr Phys Act* 14(1):75.
- Tremblay, M. S., Travis John Colley Rc Fau - Saunders, Genevieve Nissa Saunders Tj Fau - Healy, Neville Healy Gn Fau - Owen, and N. Owen. 2010. "Physiological and health implications of a sedentary lifestyle." *Appl Physiol Nutr Metab* 35(6):725-40.
- Warren, T. Y., Steven P. Barry V Fau - Hooker, Xuemei Hooker Sp Fau - Sui, Timothy S. Sui X Fau - Church, Steven N. Church Ts Fau - Blair, and S. N. Blair. 2010. "Sedentary behaviors increase risk of cardiovascular disease mortality in men." *Med Sci Sports Exerc* 42(5)(1530-0315 (Electronic)):879-85.
- Watenpaugh, D. E. 2009. "The role of sleep dysfunction in physical inactivity and its relationship to obesity." *Curr Sports Med Rep* 8(6):331-8.
- Weiler, R., D. Aggio, M. Auid-Orcid Hamer, T. Taylor, and B. Kumar. 2015. "Sedentary behaviour among elite professional footballers: health and performance implications." *BMJ Open Sport Exerc Med* 1(1):e000023.
- Whitfield, G., Harold William Pettee Gabriel Kk Fau - Kohl, 3rd, and H. W. Kohl, 3rd. 2014. "Sedentary and active: self-reported sitting time among marathon and half-marathon participants." *J Phys Act Health* 11(1)(1543-5474 (Electronic)):165-72.
- Wijndaele, Katrien, Nathalie Duvigneaud, Lynn Matton, W. Duquet, C. Delecluse, Martine Thomis, G. Beunen, J. Lefevre, and Renaat Philippaerts. 2007. "Sedentary behaviour, physical activity and a continuous metabolic syndrome risk score in adults." *European journal of clinical nutrition* 63:421-9.
- Wing, Y. K., S. X. Li, A. M. Li, J. Zhang, and A. P. Kong. 2009. "The effect of weekend and holiday sleep compensation on childhood overweight and obesity." *Pediatrics* 124(5):e994-e1000.
- Wu, X. Y., L. H. Han, J. H. Zhang, S. Luo, J. W. Hu, and K. Sun. 2017. "The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review." *PLoS One* 12(11):e0187668.
- Yang, Y., J. C. Shin, D. Li, and R. An. 2017. "Sedentary Behavior and Sleep Problems: a Systematic Review and Meta-Analysis." *Int J Behav Med* 24(4):481-92.
- Young, D. R., M. F. Hivert, S. Alhassan, S. M. Camhi, J. F. Ferguson, P. T. Katzmarzyk, C. E. Lewis, N. Owen, C. K. Perry, J. Siddique, and C. M. Yong. 2016. "Sedentary Behavior and Cardiovascular Morbidity and Mortality: A Science Advisory From the American Heart Association." *Circulation* 134(13):e262-79.
- Zhao, J., Y. Tian, J. Nie, J. Xu, and D. Liu. 2012. "Red light and the sleep quality and endurance performance of Chinese female basketball players." *J Athl Train* 47(6):673-8.