Original Article

Relationship of sedentary behaviour and body composition of university student-athletes

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Abstract

Background: Sedentary behaviour is a major health concern not only for the general population but for athletes as well. Young athletes are considered highly active individuals due to the training required in their sports and would easily meet weekly recommendations for physical activity participation. However, athletes may also have the tendency to be highly sedentary if they spend most hours of their day sitting. This may lead to undesirable changes in body composition, which may negatively affect their health and performance.

Objective: The aim of this study is to determine the relationship between sedentary behaviour and the body composition of university athletes.

Methods: Data from 82 student-athletes (age = 20.02 ± 1.3 years; 38 males and 44 females) from different sports categories were gathered and analysed. Body composition, specifically body mass index, fat mass and fat-free mass, measured through bioelectric impedance analysis. Sedentary behaviour was quantified using a self-report physical activity questionnaire.

Results: The analysis revealed no significant relationship between sitting time (hours/day) and body composition measures in both genders. A significant difference in sitting time was found when the groups were classified according to sports category ($p = 0.03$), where weight category sports ($m = 6.99$ h, standard deviation [SD] =2.74) indicated more sitting hours compared to non-weight category sports ($m = 5.81$ h, SD = 1.84). Between genders, there was no difference in reported sitting hours ($p = 0.456$); however, both groups spend relatively long periods sitting during the waking hours of the day. A moderate negative relationship was found between sports category and sitting time for the females only ($r = -0.322$, $p = 0.028$). For this population, females in the weight category had more sitting time than those in the non-weight category.

Conclusion: These results suggest that among university student-athletes, sedentary behaviour is not associated with changes in body composition. Even so, sedentary behaviour was evident among the participants; hence, the importance of educating athletes about the detrimental effects of sedentary living on health and performance becomes more vital

Key Words: Body composition, sedentary behaviour, sitting time

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INTRODUCTION

The study of sedentary behaviour has been gaining popularity within the context of human health (Biswas et al. 2015; Hills et al. 2007; LeBlanc et al. 2012; Owen et al. 2014) and performance (Chastin et al. 2011; Santos et al. 2014; Whitfield et al. 2014) within the past decade. Sedentary living and physical inactivity are major

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contributors to the prevalence of lifestyle-related diseases and the increase in mortality rates of the global population (Mendis et al. 2015; Pavey et al. 2015). One specific health problem associated with low physical activity levels is obesity (Shields and Tremblay 2008). Excessive weight gain, increased fat mass and visceral adiposity are all associated with the development of cardiovascular diseases, metabolic disorders and risk of premature death (Reilly and Kelly 2011). While within the athletic population, several studies have shown that high levels of adiposity can negatively affect sports performance as well (Nuhmani et al. 2012; Willeumier et al. 2012; Zsidegh et al. 2007).

An increase in adiposity levels caused by sedentary living raises health concerns that need to be addressed within the general population (Biswas et al. 2015), and athletes are not exempted from this. Various international health organisations and institutions have provided daily physical activity and exercise participation guidelines as a strategy to reduce obesity rates globally (Nelson et al. 2007). These recommendations are generally focussed on the quantity of time spent doing moderate to vigorous intensity activities within a weekly period. Among athletes, the recommendations are easily met through regular training and exercise sessions required for their physical conditioning and skills enhancement. However, some studies have observed that athletes who participate in high levels of physical activity may at the same time spend a significant amount of time sedentary outside their exercise training sessions (Júdice et al. 2014; Whitfield et al. 2014). One study reported that both athletes and non-athletes spend about the same amount of time being sedentary during non-exercising hours of the day (Alméras et al. 1991). Consequently, specific guidelines concerning the management of sedentary living, specifically among athletes, are not yet instituted (Weiler et al. 2015).

One important component of sedentary behaviour in relation to health is sitting time (Van der Ploeg et al. 2012). Sitting for a substantial amount of time during the waking hours of the day is considered as being in a sedentary state. Remaining in a seated or reclined position is categorised as having an energy expenditure level of below 1.5 metabolic equivalents, similar to the energy use of not moving at all (Weiler et al. 2015). Several research about the effects of prolonged sitting time has emerged due to its association with environmental and social factors that promote sedentary behaviour (Alghadir et al. 2015). More specifically, the advent of mobile technology, Internet-based entertainment, office work and better means of transportation has significantly increased the hours spent sitting in both adults and younger individuals (Biddle et al. 2011; Wibowo et al. 2019). One study concluded that prolonged sitting time during media consumption increases the risk of obesity among students 8-18 years of the age (Alghadir et al. 2015). Similar results were found in a study conducted among male elite Portuguese athletes who reported that sitting time may be considered as an independent factor that affects adiposity levels (Júdice et al. 2014). Finally, sitting time may also have an incremental negative effect on muscle strength and cardiorespiratory fitness among adolescents (Hardy et al. 2018).

Therefore, the aim of this study was to determine the influence of sedentary behaviour, specifically sitting time measured in hours per day, on the body composition of collegiate athletes from different categories of sports. Further analysis was conducted to determine the possible relationship between sedentary behaviour and the athletes sporting category, specifically weight class and non-weight class sports. To date, there are only a few studies that have explored this association and were mostly about male elite and recreational athletes (Alméras et al. 1991; Júdice et al. 2014; Whitfield et al. 2014). This study provides a novel perspective that could provide valuable insight in managing the athlete's body composition and lifestyle by addressing interrelated factors outside exercise training and nutrition.

MATERIALS AND METHODS

Participants

The study was conducted among university student-athletes ($n = 82$, Age = 20.02 ± 1.3 years; 38 Males and 44 Females) from different sport disciplines who volunteered to be a part of the research. The different sports were classified into two groups following a similar method in the study of Júdice et al. (2014). Sports wherein body weight is used to classify athletes (i.e. judo, taekwondo) were categorised as (a) weight class sports; while those sports where body weight is not used to classify athletes (i.e. basketball, volleyball, and softball) were included in the (b) non-weight class sports. For the inclusion criteria, participants should be a member of the official competing line-up of the present athletic season, has been training regularly within at least one year, not being treated for any injury or illness, and has not been taking any performance-enhancing substance or medication that can alter metabolism and body composition. All participants were informed about the purpose, procedures and data processing involved in the study. They were also told that their personal information would be kept confidential, and they may terminate their participation anytime they want. Finally, they signed informed consent and were then given a specific date for the assessment procedure. All processes and methods applied within this study were done in accordance with the ethical principles stated in the Declaration of Helsinki for human studies of the World Medical Association (2001).

Research design

The schedule of the testing dates was set 1 month before the commencement of the national inter-varsity competitive season. This ensured that all participants were regularly training in preparation for the upcoming games of their sport. The different varsity team members who volunteered for the study were assigned separate testing dates within a 3-week period. A week before the assigned testing date, the participants were given instructions through E-mail about the pre-testing procedures, which includes 8 h of fasting, 24 h of no alcohol consumption, and avoidance of any strenuous activity or exercise the day before the testing date. All tests were conducted in one session within the morning of the regular school week. On the arrival of the participants in the testing venue, they were given an overview of the procedures, instructions on what to do in each testing station, and a consent form. On the testing date, the procedures conducted are the following:

Sedentary behaviour-sitting time

A copy of the International Physical Activity Questionnaire (IPAQ)–self-administered Short Form (Bauman et al. 2009) were given to the participants right after the initial briefing. Sedentary behaviour was quantified through questions about the amount of time spent sitting during the waking hours of the day of the athlete (Júdice et al. 2014). This determined the accumulated hours spent sitting at home, work, study, transport and/or leisure time. Previous studies (Marshall et al. 2010; Rosenberg et al. 2008) showed acceptable reliability and validity of the use of these specific questions to determine sitting time.

Body composition

Bodyweight was measured with no footwear and minimal clothing to the nearest 0.1 kg using a weighing scale (Tanita Inner Scan Dual Frequency Body Composition Analyzer RD-901). Standing height was then obtained through a wall-mounted stadiometer to the nearest 0.1 cm. Body fat (BF), visceral fat (VF) and fat-free mass (FFM) percentages were measured through a segmental body composition scale (Omron HBF-375 bioelectric-impedance analysis BIA). To ascertain the accuracy of the BIA test, the participants should: (1) have not taken any diuretic medication within the week; (2) have fasted in at least 4 h; (3) abstained from consuming any alcoholic beverages in the last 48 h; (4) have not participated in intense physical activity in the last 24 h; (5) urinated within at least 30 min before the test (Guedes 2013).

Statistical analysis

Results were reported as mean ± standard deviation [SD] and significance level set at $p < 0.05$. Normality was assessed using the Shapiro–Wilk test and the analysis of results performed using Pearson correlation or Spearman's rho and independent samples *t*-test or Mann–Whitney U (SPSS, IBM Statistical Package v. 20) where appropriate.

The data were first analysed to determine if there was a significant difference between 1. Gender (Male vs. Female) and 2. Sports category (weight vs. non-weight) for the main research variables sitting hours and body composition. The data were split according to these initial findings before further correlational analysis was done.

RESULTS

Details about the participants analysed by gender (male and female) are shown in Table 1. The results show the significant difference between male and female characteristics in terms of height, weight, %body fat and % fat-free mass. There was no difference found, however, for their reported sitting hours ($p = 0.456$).

When the data were analysed by sport category, significant differences were found between groups in height and weight [Table 2]. A significant difference was found for sitting hours of the weight category (m = 6.99, SD = 2.74) and non-weight category (M = 5.81, SD = 1.84); t (80) = 2.213, $p = 0.03$.

Since significant differences in body composition measures were found across genders and sitting hours across sports categories, the data were analysed separately for males and females and by sport category [Table 3].

Analysis was performed for sitting hours for the sports categories (weight and non-weight category) separated by gender (male and female). For males, using Mann–Whitney U for independent samples, results revealed the sitting hours was not significantly different ($p = 0.294$) across sports categories. As shown in the boxplot below, the female distribution of sitting hours was significantly different across sports categories $t = 2.279$, $p = 0.028$.

The sitting hours for the males and females were likewise analysed per sports category (weight and non-weight category). The distribution of sitting hours was not significantly different across genders for the weight category $t = -1.259$, $p = 0.223$, and non-weight category $t = 0.855$, $p = 0.396$.

For the males, there was no significant relationship found between sport category and sitting time ($r = 0.145$, $p = 0.371$); BMI ($r = -0.029$, $p = 0.860$) and %body fat (r = 0.132, $p = 0.418$). While for the females, there was no significant relationship found between sitting time and BMI (r = 0.007, $p = 0.960$) and %body fat ($r = 0.047$, $p = 0.749$). A moderate negative relationship was found between sports category and sitting time ($r = -0.322$, $p = 0.028$, $R^2 = 0.104$). This means that females in the weight category had significantly more sitting time than the females in the

Table 1: Male and female characteristics, measures of body composition and sitting hours

	Mean±SD		*P* (significant at *P*<0.05)*
	Male (*n*=38)	Female (*n*=44)	
Age (years)	20.03±1.27	20±1.36	NS
Height (m)	1.74±0.68	1.58±0.079	0.000*
Weight (kg)	66.61±12.68	57.99±12.69	0.003*
BMI	22.32±2.56	23.08±4.34	0.352
Body fat (%)	16.38±7.12	25.86±6.11	0.000*
FFM (%)	83.61±7.12	74.14±6.11	0.000*
Sitting hours (per day)	5.92±1.55	6.28±2.58	0.456

*Significant at $p<0.05$; NS or $p>0.05$. *n*: Number of participants, SD: Standard deviation, BMI: Body mass index, FFM: Fat free mass, NS: Not significant

Table 2: Classified by sport category, participants body composition and sitting hours

	Mean±SD		*P* (significant at *P*<0.05)*
	Weight category (*n*=21)	Non-weight category (*n*=61)	
Height (m)	1.56±0.05	1.69±0.1	0.000*
Weight (kg)	55.84±9.09	64.11±13.94	0.013*
BMI	22.81±3.63	22.69±3.64	0.889
Body fat (%)	24.14±7.23	20.55±8.22	0.080
FFM (%)	75.86±7.23	79.45±8.22	0.080
Sitting hours (per day)	6.99±2.74	5.81±1.84	0.030*

*Significant at $p<0.05$. *n*: Number of participants, SD: Standard deviation, BMI: Body mass index, FFM: Fat free mass

Table 3: Male and female data classified according to sport category (weight or non-weight)

	Male, mean±SD		Female, mean±SD	
	Weight (*n*=3)	Non-weight (*n*=35)	Weight (*n*=18)	Non-weight (*n*=26)
Height (m)	1.65±0.02	1.75±0.06	1.55±0.04	1.61±0.08
Weight (kg)	60.60±10.14	67.12±12.86	55.04±8.98	60.04±14.55
BMI	22.30±4.03	22.32±2.48	22.90±3.68	23.19±4.81
Body fat (%)	13.03±5.12	16.67±7.25	25.99±5.76	25.77±6.45
FFM (%)	86.97±5.12	83.33±7.25	74.01±5.76	74.23±6.45
Sitting hours (per day)	5.17±0.29	5.99±1.59	7.29±2.86	5.58±2.14

SD: Standard deviation, BMI: Body mass index, FFM: Fat free mass

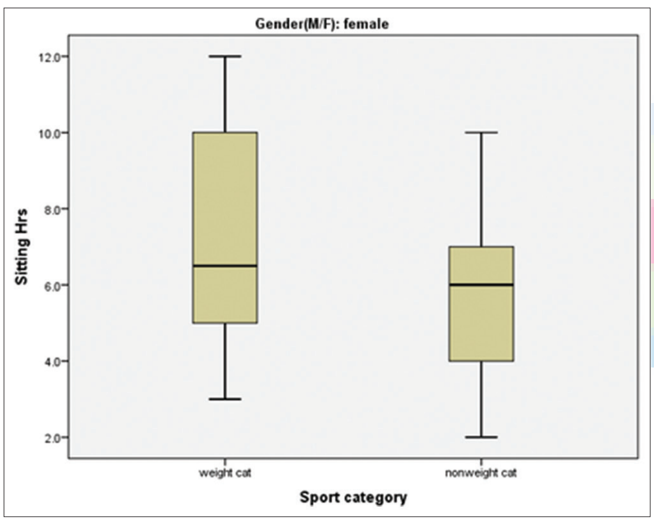

Figure 1: Female athlete's sitting hours per sport category

non-weight category [Figure 1]. The low value for R^2 indicates that the sports category is not accounting for much of the variability from the mean sitting time values; hence, even if a significant relationship was established in the female participants, the sports category cannot always effectively predict sitting time.

DISCUSSION

This study explored the relationship between sedentary behaviour and body composition measures of collegiate athletes from different sport disciplines. Sitting time denoted as hours per day was the primary measure for sedentary behaviour, while BMI, BF and FFM levels were obtained through a BIA electronic device. In the data analysis, no significant associations between sitting time and body composition measures were observed in both weight and non-weight category sports groups. This outcome is similar to the findings of previous studies (Júdice et al. 2014; Saunders et al. 2013). A possible explanation for this is that athletes regularly participate in moderate-to-vigorous levels of physical activities from their sports and exercise training, facilitating the maintenance of muscle mass and strength (Lo et al. 2011). However, the lack of correlation found between BF and sedentary behaviour is contrasting to the study by Júdice et al. (2014), which proposed that sitting time may be considered as an independent factor to the increase in total body fat level. Although a major difference of our study is the inclusion of female athletes, as most of the previous researches (Alméras et al. 1991; Júdice et al. 2014; Silvestre et al. 2006; Zsidegh et al. 2007) focused on males. The role of gender differences linked to body composition and physiological state (Altavilla et al. 2017) may have influenced the general outcome of the analysed data. Thus, we suggest that future studies consider and further explore these differences to better understand how it relates to sedentary behaviour among athletes.

A significant difference in sitting hours between the two categories of sports, weight and non-weight categories, was found. Moreover, sitting hours per day was higher in the weight category sports group compared to the non-weight category sports group (6.99 ± 2.74 h and 5.81 ± 1.84 h, respectively). This trend has been previously reported (Júdice et al. 2014); however, the explanation on why this happens remains unclear. As presumed, athletes in weight class sports are expected to be more conscious of their body weight and fat mass due to the nature of their sport (Cruz 2010). This may be an indication that athletes, even those who are trying to maintain a certain body condition, are not yet aware of the possible adverse effects of sedentary behaviour (Biswas et al. 2015) commonly caused by prolonged sitting time.

Within the context of sedentary behaviour involving athletes, more research is required to establish interventions and recommendations that would specifically benefit them. Existing daily physical activity recommendations, such as the 150 min per week of the moderate-to-vigorous intensity of the American College of Sports Medicine guidelines (2013), are focused on the accumulation of moments spent being active rather than reducing time being sedentary. Young athletes can easily attain these recommendations due to their regular training bouts; however, they can also be highly sedentary if they spend the rest of their waking hours sitting down. This suggests that athletes may have the same potential as non-athletes in developing higher adiposity levels (Larsen et al. 2014) if they are sedentary within their non-training hours.

There are other notable findings that may provide valuable insights related to sedentary behaviour among young athletes. The data showed that both male and female athletes spend a significant amount of time sitting, averaging 5.92 ± 1.5 h and 6.3 ± 2.5 h, respectively, during the waking hours of the day. This data are similar to an earlier study (Júdice et al. 2014) amongst highly trained athletes, which reported an average sitting time of 7.70 ± 2.70 h. In the same study, it was indicated that athletes who spend a significant amount of time sitting, regardless of the active time spent sports training, had higher overall and trunk adiposity levels. One study (Savegnago Mialich et al. 2014) mentions that a high-fat ratio, especially among university students, should be a concern as it may develop into health problems associated with high adiposity levels. A meta-analysis on sitting time and its relation to all-cause mortality reported that sitting for more than 7 h per day significantly increased risk factors linked to adverse health outcomes (Chau et al. 2013). Since high amounts of sitting time were observed, this implies a possible carry-over of sedentary behaviour within the lifestyle of the athlete (Weiler et al. 2015). Thus, to reduce the long-term negative effect of physical inactivity, especially after the sporting career of the athletes, coaches and educators should consider integrating interventions that would improve and establish the athlete's positive behaviour (Castro et al. 2020) towards physical activity even after retirement from sports.

Since the study aimed to gather data from a set sample size according to the athletic population of the university, one limitation of this study is the use of the BIA method in estimating the athlete's body composition due to its availability and convenience. The testing method's reliance on regression models (Lukaski 1999) and indirect assessment of body composition may not have given the same accuracy if compared to direct measures such as dual-energy X-ray absorptiometry and magnetic resonance imaging (Talma et al. 2013). In spite of this, the BIA method has been considered as a validated and acceptable means in measuring body composition (Hosking et al. 2006; Karelis et al. 2013; Lukaski et al. 1986). Moreover, the participant's daily sitting time was measured using an IPAQ short-form questionnaire. The use of pen-and-paper style or indirect methods to gauge sedentary behaviour has inherent limitations as well. The participant's responses are based on recalling past events, which may not be a true account of the actual accumulated sitting time. With the advancement of technology in human behaviour research, future studies may opt to use wearable activity trackers (Stackpool et al. 2013). This relatively new method may provide a direct, comprehensive and accurate representation of the athlete's overall physical activity level. In addition, recent studies recommend applying comprehensive approaches, such as the Behaviour Change Wheel (Castro et al. 2020), in determining correlates that increase the sitting time of young individuals. This would provide a way to determine the appropriate interventions for behaviour change strategies to decrease sedentary behaviour in one's lifestyle.

CONCLUSIONS

The present study shows that sitting time, as a measure of sedentary behaviour, did not have a substantial association with body composition measures. However, results were consistent with previous studies indicating that athletes spend a significant amount of time being sedentary outside their training schedules. This infers that athletes, even if they are participating in regular exercise and training sessions, are also susceptible to lifestyle habits that may increase physical inactivity. It is also noteworthy that this occurrence varies significantly across the different sports categories, which should be further examined and understood in future research. Therefore, it is important for educators and coaches to raise awareness and educate athletes about the negative effects of sedentary behaviour, not only within the context of sports performance but also for long-term health as well.

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Conflicts of interest

There are no conflicts of interest.

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