Research Article

Association between Physical Activity and Sitting Time Related to Excess Body Weight in Brazilian University Students

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Abstract
High exposure to sedentary behavior and lower levels of physical activity can lead to excess body weight (EBW). The aim of this study was to estimate the prevalence of EBW and the direct association under the condition of sociodemographic, university, and behavioral moderating characteristics, between physical activity and sitting time related to EBW in Brazilian university students. A cross-sectional study was carried out with 1,110 university students from a federal public institution in Minas Gerais, Brazil. The outcome was the EBW (body mass index: ≥25.0 kg/m^2) and the independent variables were physical activity (insufficiently active and active) and sitting time (<6 h/day; ≥6 h/day). Association analyses were estimated via odds ratio (OR) using binary logistic regression. The significance level was 5%. The prevalence of EBW was 27.8%. No direct association was observed between physical activity and time sitting related to EBW. However, insufficiently active university students were more likely to have EBW (OR = 1.91; 95% CI: 1.06–3.47) when they did not consume alcoholic beverages, and university students with a sitting time of ≥6 h/day had lower chances of having EBW (OR = 0.62; 95% CI: 0.40–0.95) when they had spent more time at university (3 years or more). It is concluded that the prevalence of EBW in university students was high and there was no direct association between physical activity and sitting time; however, alcohol consumption and university time moderated the association with higher and lower chances of occurrence of EBW in university students, respectively.

Associação entre atividade fÍsica e tempo sentado em relação ao excesso de peso corporal em estudantes universitários brasileiros

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Resumo

A elevada exposição ao comportamento sedentário e menores níveis de atividades físicas podem acarretar o excesso de peso corporal (EPC). Os objetivos deste estudo foram estimar a prevalência de EPC e a associação direta e sob a condição das características moderadoras sociodemográficas, de vínculo com a universidade e comportamentais, entre a atividade física e o tempo sentado em relação ao EPC em universitários brasileiros. Realizou-se um estudo transversal com 1.110 universitários de uma instituição pública federal de Minas Gerais, Brasil. O desfecho foi o EPC (índice de massa corporal: ≥25,0 kg/m^2) e as variáveis independentes foram a atividade física (insuficientemente ativos e ativos) e o tempo sentado (<6 horas/dia; ≥6 horas/dia). As análises de associação foram estimadas via Odds Ratio (OR) por meio da Regressão Logística Binária. O nível de significância foi de 5%. A prevalência de EPC foi de 27,8%. Não foi observada associação direta entre a atividade física e tempo sentado sob o EPC. No entanto, os universitários insuficientemente ativos apresentaram maiores chances de EPC (OR = 1,91; IC95%: 1,06 – 3,47), quando não consumiam bebida alcoólica e os universitários com tempo sentado ≥6 horas/dia apresentaram menores chances de EPC (OR = 0,62; IC95%: 0,40 – 0,95), quando apresentaram maior tempo de universidade (3 anos ou mais). Conclui-se que a prevalência de EPC em universitários foi elevada e não houve associação direta entre a atividade física e o tempo sentado em relação ao EPC, porém, o consumo de álcool e o tempo de universidade moderaram a associação com maiores e menores chances da ocorrência de EPC em universitários, respectivamente.

Introduction

The health of university students represents a construct of interest to researchers [1], due to the adoption of behaviors that leave them exposed to chronic non-communicable diseases during their academic lives [1]. These behaviors favor the risk of excess body weight (EBW), that is, overweight (body mass index [BMI]: 25–29.9 kg/m^2) and obesity (BMI: ≥30 kg/m^2), both in men and women [2, 3], and research points to increasing prevalence and/or incidence of EBW in university students [2, 3].

Risk behaviors such as insufficient physical activity [1] and long time spent in sedentary behaviors [4] can be direct determinants in the development of EBW [1, 4]. Sedentary behavior is related to energy expenditure in activities that correspond to <1.5 metabolic equivalents in sitting, reclining, or lying positions [5]; on the other hand, the minimum physical activity necessary to obtain benefits must be at least 150 min in moderate intensity or 75 min at a vigorous intensity or a combination of both intensities [6].

These behaviors at inappropriate levels, in addition to being directly associated with the EBW [3, 4], may have their effects modified by other characteristics due to interactions that can maximize or minimize the occurrence of this outcome. This peculiarity is called the moderating effect due to a variable that affects the direction and/or strength of the relationship between the investigated characteristics [7]. Studies have shown that the country where the participants live represented an important moderator of the association between physical activity and sedentary time in relation to EBW, as well as food business points modified the effect of the association between sedentary time and EBW in elderly people [8] and that the level of cardiorespiratory fitness showed interaction with physical activity in association with EBW in children and adolescents [9].

In view of the information in the literature that shows the impact of physical activity [3] and sedentary behavior [4] in relation to EBW, such as obesity in university students [10], it is essential to characterize the role of possible moderators in the association of physical activity and sitting time considering the health risk condition of EBW. Possibly sociodemographic factors, such as gender (male), the relationship with the university itself due to exposure to the academic experience, as well as dietary aspects, such as the consumption of alcoholic beverages [2, 3, 10], can moderate this relationship. The study of this topic is extremely relevant since at least 2.8 million deaths every year result from the EBW [11] and the information from this type of research may support the development of programs/projects at the university and institutional policies focused on EBW. Therefore, the objectives of this study were to estimate the prevalence of EBW and verify the direct association, considering sociodemographic, university, and behavioral moderating variables, between physical activity and sitting time related to EBW in Brazilian university students.

Materials and Methods

This cross-sectional study is part of the first survey of the study "Profile of Lifestyle and Quality of Life of Students at the Federal University of Triângulo Mineiro (UFTM)," carried out in 2018 at a

public university in the state of Minas Gerais, Brazil. The research was approved by the Research Ethics Committee (CEP) of UFTM with protocol number: 2.402.734. The target population was university students enrolled in the first academic semester in presential undergraduate courses at UFTM, Uberaba-MG, during the day and night shifts.

For the sample size calculation [12], a target population of 5,952 university students, a prevalence of 50% due to a lack of knowledge of the outcomes, a confidence level of 95%, and an acceptable sampling error of three percentage points were considered. Finally, 20% were added for losses and another 10% for control of confounding factors in association studies, based on the study of repeated surveys with samples of Brazilian university students, who participated by simple random selection, and observed losses among 12% and 15% [13] and the research with adults [14], which used a sample increase of 15% to perform the multivariate analysis. Thus, in this study, an estimated sample of 1,195 university students was calculated.

As a way of standardizing the data collection, in March 2018, the training of the team composed of undergraduate and postgraduate students in Physical Education at UFTM was carried out. Subsequently, between the months of April and July of the same year, the process for data collection was carried out, by verifying the occurrence of classes and applying the instrument in a similar way to the volunteers, in small groups of up to 30 people or individually, on the university premises, thus ensuring a similar location but on different days of the week.

To ensure the proportional participation of university students, the sample was stratified according to the distribution of university students among the institution's 25 courses. The participation process was for convenience. University students aged 18 years or older were included, regardless of gender and physical conditions. University students from distance learning courses, with special enrollment (students with a higher education diploma who enroll in undergraduate courses), technical courses and courses belonging to the Iturama Campus (Agronomy, Licentiate in Biological Sciences and Chemistry) were excluded. The Iturama Campus is linked to the UFTM, which was inaugurated on February 13, 2015, and, due to the little time of implantation and structure, it was excluded from the research. These exclusions occurred after tabulating the information. Such actions were possible due to the questions inserted in the instrument.

The information was obtained by self-completion of a questionnaire, with the supervision of a researcher. The instrument consisted of questions from the Academic Health and Quality of Life Indicators (ISAQ-A) [15] questionnaire, validated for Brazilian university students, and the International Physical Activity Questionnaire (IPAQ) [16], validated for research with young adults.

The dependent variable was BMI and the outcome was EBW ($\geq$25 kg/m^2), calculated using the aforementioned measurements of body mass and height using the standard equation of the World Health Organization [17]. Height in meters and body mass in kilograms, both referred to, present satisfactory levels of reproducibility (by analyzing the Bland-Altman scatter plot, the mean difference being −0.002, 95% CI: −0.006 to 0.003, and mean difference 0.36, 95% CI: −0.19; 0.91), respectively [13] and have concurrent validity with acceptable levels of sensitivity and specificity [18] for studies with university students [15, 18].

The independent variables were the practice of physical activities and sitting time, measured by the IPAQ [16]. Moderate to vigorous physical activity (MVPA) per week was classified as up to 149 min (insufficiently active) and 150 min or more (active), according to the Physical Activity Guide for the Brazilian population [6]. The minutes of vigorous-intensity practice were multiplied by two in the composition of the total time [14]. The IPAQ measure of physical activity has satisfactory validity (Spearman correlation, rho = 0.75) in a sample of Brazilian adults [16].

Sitting time was estimated by the time in the sitting position, between Monday and Friday, and on a weekend day by calculating the weighted average on a day of the week, later classified as <6 h and $\geq$6 h a day [19]. This measure has a concurrent validity level (rho) of 0.79 in Brazilian adults [16] and satisfactory concurrent validity in Brazilian university students [20] through the intraclass correlation coefficient (ICC) for the time in the week (ICC = 0.31) and weekend (CCI = 0.53) [20] compared to the accelerometer.

The moderating sociodemographic variables were gender (male and female) and age, which was dichotomized (18–24 years old and 25 years old or older) based on the characteristics of the ages of college students who participated in research on EBW [2] and time at university categorized according to previously used criteria [10], in up to 2 years, which corresponds to the first half of the time to complete the training in the course, and 3 years or more (second half of the course), since most courses take 4 years to conclude on a regular basis [10] and period of study (day and night); behavioral variables were fruit consumption [21] (up to 4 days a week; 5 or more days a week); consumption of vegetables [21] (up to 4 days a week; 5 or more days a week); consumption of fatty red meat [22] (none and 1 or more days a week); the consumption of chicken with the skin, without removing the visible fat [22] (none and 1 or more days a week); consumption of snacks [22] (none and 1 or more days a week); consumption of soft drinks or artificial juices [22] (up to 4 days a week and 5 or more days a week); consumption of alcoholic beverages [23] on one occasion in the last 30 days, with 5 doses or more for men and 4 doses or more for women (no and yes).

The information was tabulated in Excel software, version 2013, and data analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 24.0. Analyzes of absolute and relative frequencies, mean and standard deviation (SD) were used. The association between physical activity and sitting time with EBW and moderating variables were performed using the odds ratio (OR) and 95% confidence intervals (95% CI), through binary logistic regression.

Initially, the crude and adjusted associations between MVPA and sitting time related to EBW were estimated, and the adjustment was performed with all moderating variables simultaneously (sociodemographic, university link, and behaviors). After that, the interactions between each behavior (physical activity and sitting time) were analyzed with each moderating variable isolated and with adjustment for the others in relation to the outcome. The interaction between physical activity and sitting time was also analyzed. Of the interactions that were associated with the outcome, the effects of the association with the stratification of the analysis by the moderating variable were observed. The significance level adopted was 5%.

Table 1. Characterization of the sample considering the sociodemographic, university, and health-related behaviors variables in university students

Variable	N	%
Gender		
Male	422	38.2
Female	683	61.8
Age		
18–24 years	978	88.1
25 or more years	132	11.9
Study period		
Night	291	26.2
Day	818	73.8
University time		
Up to 2 years	566	51.1
≥3 years	541	48.9
Fruit consumption		
Up to 4 days a week	830	75.1
5 or more days a week	275	24.9
Consumption of vegetables		
Up to 4 days a week	589	53.3
5 or more days a week	516	46.7
Consumption of fatty red meat		
None	114	10.4
1 day or more	982	89.6
Consumption of chicken with skin		
None	457	41.4
1 or more days a week	648	58.6
Consumption of snacks		
None	156	14.2
1 or more days a week	945	85.8
Consumption of soft drinks		
Up to 4 days a week	877	79.2
5 or more days a week	231	20.8
Consumption of alcoholic beverages		
No	348	31.4
Yes	759	68.6
MVPA		
Active	791	72.3
Insufficiently active	303	27.7
Sitting time		
<6 h a day	265	24.1
6 h or more per day	834	75.9

MVPA, moderate to vigorous physical activity. Minas Gerais. 2018.

Results

The final sample of this study consisted of 1,110 university students with a mean age of 21.5 years (SD = 4.2; minimum of 18; maximum of 56). Most participants were female (61.8%), studied during the day (73.8%) and with up to 2 years of university study (51.1%) (Table 1). It was observed that the majority reported consumption of up to 4 days a week of fruits (75.1%) and vegetables (53.3%). As for the consumption of fatty red meat, 89.6% of the university students reported this habit, and 58.8% reported the consumption of chicken with the skin, without removing the visible fat. Regarding the consumption of snacks and soft drink consumption for up to 4 days a week, prevalence rates of 85.8% and 79.2%, respectively, were observed, and 68.6% reported having consumed alcoholic beverages. As for performing MVPA, 27.7% were insufficiently active, and 75.9% reported spending 6 h or more in sitting time. The prevalence of EBW in university students was 27.8% (shown in Fig. 1).

In the crude and adjusted analyses (Table 2), there was no direct association between MVPA and sitting time regarding EBW. However, in the association between MVPA and EBW, there was interaction in the presence of alcohol consumption, and between sitting time and EBW, there was interaction in the presence of university time.

It was observed that insufficiently active university students were more likely to have EBW (OR: 1.91; 95% CI: 1.06–3.47) when they did not consume alcoholic beverages (Fig. 2a). Figure 2b shows that being at university for 3 years or more modified the effect of the association between sitting time and EBW in university students (OR: 0.62; 95% CI: 0.40–0.95).

Discussion

It was noted in this study that for every 100 university students, approximately 28 had EBW. There was no direct association between MVPA and sitting time related to EBW; however, in the association between MVPA and EBW, there was an interaction with the consumption of alcoholic beverages, and in the association between sitting time and EBW, there was an interaction with the university time.

In this study, it was observed that the high prevalence of EBW among university students is like most studies carried out in different countries, as observed in a recent systematic review on the subject [2]. The increase in the prevalence of EBW can occur throughout academic life [2], both in men and women [2, 3], depending on the time in the university [2]. This occurrence may be linked to the proportion of university students who adopt unhealthy behaviors, such as excessive alcohol consumption, levels of physical activity below the recommended guidelines, and inadequate eating habits [1]. Through this study, it is possible to characterize the need for public health
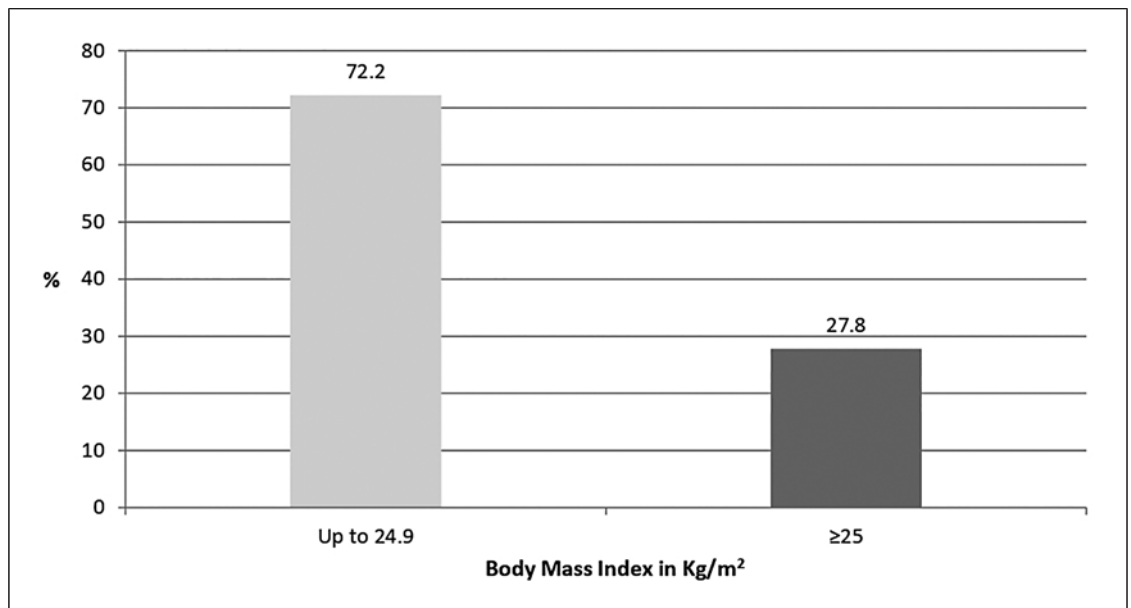
Fig. 1. Prevalence of EBW in university students, Minas Gerais, 2018.

policies, as well as institutional actions, aimed at neutralizing the increase in EBW and promote actions aimed at healthy behaviors.

The direct effect between MVPA and EBW was not found, which is like the study with Colombian university students [24]. Results like these are not uncommon because, due to the study design (cross-sectional), physically active college students may be on EBW, thus seeking to maintain body weight. Above all, regular physical activity is essential to prevent inappropriate weight gain in university students [2, 22].

Although there was no association between MVPA and EBW, an interaction was noted in the presence of alcoholic beverages. The observed effect corresponded by increasing the chances of EBW for those university students who did not meet the MVPA recommendations when they did not consume alcoholic beverages. The relationship between the consumption of alcoholic beverages and the regular practice of physical activity has been shown in the literature, even when investigating social sports practices promoted by university students [25, 26]. Possibly, the university students who did not meet the MVPA recommendations were those who were not involved in social activities that favor the consumption of alcoholic beverages, like sports games or leisure activities on weekends and festive events; however, these findings deserve a better understanding regarding the impact of beverage consumption on the relationship between MVPA and EBW.

In this study, there was no direct association between excessive sitting time and EBW in university students. This characteristic was also observed in university students from South Asian countries [27]. Possibly, remaining in a sitting position, regardless of time, did not discriminate against EBW among the university students in this study, as it does not represent one of the main determining factors for the onset of this condition since, as observed in a recent systematic review, economic, psychosocial, and family history can effectively contribute to EBW [2]. However, it is important to note that sitting time is an important EBW discriminator in this group [4], as it is considered that the longer the sitting time, the lower the caloric expenditure [28], as it corresponds to <1.5 metabolic equivalents [5] and thus facilitates weight gain [28], with greater chances of obesity [10]. It is suggested that the reduction of sitting time be encouraged, providing time in the standing position and with physical activities, even light ones, as a potential solution to minimize a sedentary lifestyle and prevent weight gain and obesity in the long term [28].

This study showed that university students with 6 h or more of sitting time had lower chances of EBW, with the presence of longer university experience, that is, 3 years or more. During the undergraduate course, university students spend a lot of time sitting, but they can also take a lot of breaks from this behavior, especially through involvement in supervised internships and other extension activities, which normally take place in the second

Table 2. Crude and adjusted analyzes between MVPA and sitting time related to EBW in university students. Interaction estimates via odds ratio by binary logistic regression

Variables	n	%	Crude OR	p value	Adjusted OR*	p value
MVPA						
Active	213	27.0	1.00	0.46	1.00	0.49
Insufficiently active	87	29.3	1.12 (0.83–1.50)		1.12 (0.81–1.54)	
Sitting time						
<6 years	81	30.8	1.00	0.14	1.00	0.56
6 h or more	216	26.2	0.80 (0.59–1.08)		0.91 (0.66–1.26)	
Interactions						
Gender × MVPA					1.30 (0.68–2.50)	0.43
Age × MVPA					1.04 (0.42–2.59)	0.93
Study period × MVPA					0.58 (0.29–1.16)	0.12
University time × MVPA					0.97 (0.51–1.81)	0.92
Fruit consumption × MVPA					1.35 (0.63–2.89)	0.44
Vegetable consumption × MVPA					1.68 (0.89–3.19)	0.11
Meat consumption × MVPA					2.04 (0.64–6.55)	0.23
Chicken consumption × MVPA					0.63 (0.33–1.19)	0.15
Snacks consumption × MVPA					1.14 (0.47–2.77)	0.77
Soft drink consumption × MVPA					0.89 (0.42–1.89)	0.76
Consumption of alcoholic beverages × MVPA					0.46 (0.23–0.90)	0.02
Gender × sitting time					0.63 (0.33–1.19)	0.16
Age × sitting time					1.11 (0.46–2.65)	0.82
Study period × sitting time					0.60 (0.30–1.24)	0.17
University time × sitting time					0.43 (0.22–0.84)	0.01
Fruit consumption × sitting time					1.39 (0.64–3.01)	0.41
Vegetable consumption × sitting time					1.14 (0.60–2.17)	0.70
Meat consumption × sitting time					0.40 (0.11–1.39)	0.15
Chicken consumption × sitting time					0.77 (0.39–1.53)	0.46
Snacks consumption × sitting time					1.02 (0.44–2.38)	0.96
Soft drink consumption × sitting time					0.48 (0.21–1.09)	0.08
Consumption of alcoholic beverages × sitting time					1.54 (0.76–3.12)	0.23
Sitting time × MVPA					0.73 (0.35–1.52)	0.40

OR, odds ratio; 95% CI, confidence interval at 95%; ×, multiplication between two variables; MVPA, moderate to vigorous physical activity; *Adjusted for the other variables in the table, except for the variables that were being investigated as moderator and as independent variables. Minas Gerais. 2018.

half of the courses. It is believed that performing these breaks while sitting, with longer intervals, could explain the result of this study [29].

This study has some limitations, such as the selection of the sample by convenience, as this sampling process can cause vulnerability or present trends due to the participation bias with a greater propensity for those who are healthier [26]. In this context, the sample was stratified by courses, in order to minimize the tendency for students to participate; the measurements of body mass and height were self-reported, which can cause possible response errors; however, it is a valid way of measuring EBW in university students [18]; the use of a questionnaire may be a bias, as it depends on the participant's ability to remember the information [30]; on the other hand, the questionnaires used in this study have satisfactory levels of reproducibility [15, 16] and validity [15, 20]. The representativeness of the sample in relation to the 25 courses of the institution and the short period of data collection, which could be influenced by the weather, festive holidays, and the end of the school semester, can be considered strengths of this study. This study presents the results of the master's thesis (online suppl. information; for all online suppl. material, see https://doi.org/10.1159/000530858) and brings important information for both universities and university students, as
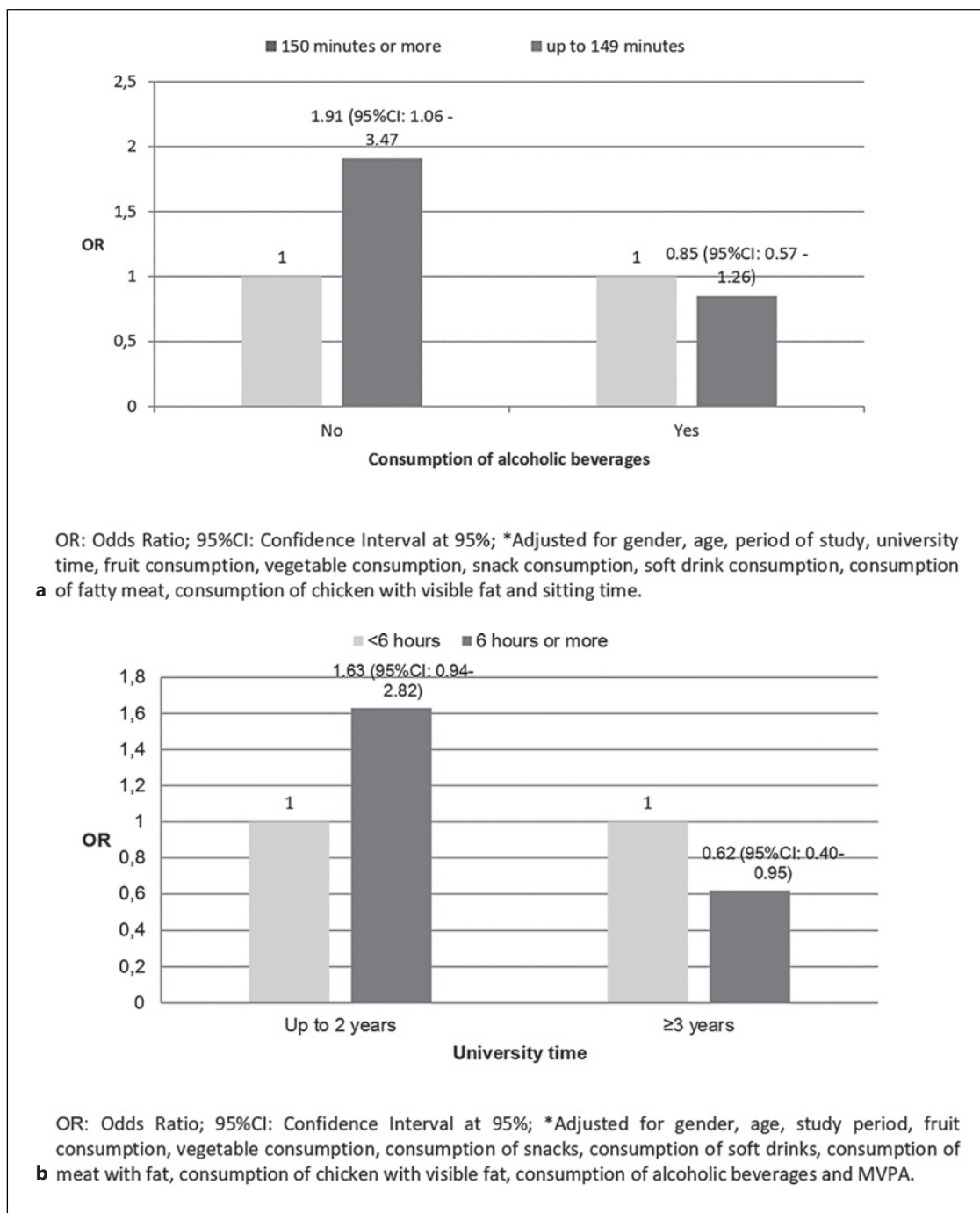
Fig. 2. a Consumption of alcoholic beverages. **b** Moderating effect of alcohol consumption and University time on the association between physical activity and sitting time related to EBW in university students. Minas Gerais, 2018.

they can implement possible projects, aiming to reduce the levels of sitting time and increase the level of physical activity with a special focus on EBW.

In conclusion, the prevalence of EBW in university students was high; however, there was no direct association between MVPA and sitting time in relation to the outcome; on the other hand, it was found that alcohol consumption and university time moderated the association of MVPA and sitting time with EBW, respectively, among university students.

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Acknowledgments

Statement of Ethics

Participation was voluntary, and written informed consent was obtained from all enrolled participants. All information was handled with confidentiality. The Research Ethics Committee (CEP) of the Federal University of Triângulo Mineiro approved the research with protocol number: 2.402.734.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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Author Contributions

G.R.B. participated in the initial study design, writing, and data analysis; S.F.S.S. and A.C.R.A. performed the critical review of the manuscript; T.F.S. participated in the initial study design, writing, data analysis, article orientation, and critical review of the manuscript. All authors approved the final manuscript.

Data Availability Statement

The data that support the findings of this study are openly available in repository Plataforma Sucupira, available at: https://sucupira.capes.gov.br/sucupira/public/consultas/coleta/trabalhoConclusao/viewTrabalhoConclusao.xhtml?popup=true&id_trabalho=9743872.

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