Analysis of the reallocation of time spent sitting, sleeping, and performing physical activities under negative self-rated heath of university students

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Abstract

The aim of this study was to examine the effect of isotemporal substitution of physical activity, sedentary, and sleep time in relation to negative self-rated health (SRH) in university students from a public university in the state of Minas Gerais, Brazil. A cross-sectional study was carried out, in which data were obtained via a questionnaire and the study's outcome was the negative SRH. The time per day spent on physical activity, sitting, and sleeping were standardized by constants of 10, 30, and 60 minutes. The isotemporal substitution model was used through the estimation of the Odds Ratio via binary logistic regression. The significance level was 5%. A total of 1,110 students participated in this study. It was observed that replacing 10, 30, or 60 minutes per day of sitting time for the same amount of time in physical activity reduces the probability of negative SRH among university students. In general, greater probability of negative SRH were observed when replacing the same times of physical activity with sitting time. No association was observed with sleep time reallocation. It is concluded that replacing at least 10 minutes of sitting time with physical activity can progressively reduce chances of negative SRH among university students.

Keywords: Health Conditions. Students. Universities. Health-related behaviors.

INTRODUCTION

Self-rated health (SRH) is a measure used since the 1970s[1,2] and is used worldwide in epidemiological studies[3-6], as it satisfactorily represents the health level of the population. Obtained by a single question considered valid to diagnose the population's health conditions, it is a construct recommended by the World Health Organization[7].

Studies have shown that negative SRH can consistently predict morbidity and mortality[8], in addition to its association with health risk-taking behaviour[9]. As it is a low-cost and easy-to-apply measure, it has been used in studies with different populations, such as children[10], adolescents[11], adults[12], the elderly[13], and with university students[14].

In a systematic review[15] on SRH of university students, it was concluded that multiple characteristics can determine SRH, such as those from sociodemographic, psychosocial, behavioral, lifestyle, and quality of life. Among university students, the prevalence of negative SRH has ranged from 3.4% to 44.3% in national and international studies[16,17] and it was observed that

health-related behaviors such as inadequate sleep, physical inactivity during leisure time, and high sedentary behavior are factors associated with negative SRH in this group[18-20].

Considering that the low level of physical activity, high sedentary time, and low sleep time are unhealthy behaviors that can be part of the daily habits of university students[17,21,22], in recent years there has been a growing interest in epidemiological studies to explore how changing the time spent on a certain activity by another can influence health-related outcomes[23,24]. Research has shown that replacing time spent on sedentary behavior with moderate to vigorous physical activity is associated with better health[25,26]. Among Brazilian university students, the reallocation of time from computer use in research (30 minutes) to the practice of physical activities during leisure time increases chances of positive SRH[14].

In this view and considering the increase in university enrollment in Brazil[27], as well as changes related to lifestyle, such as lower levels of physical activity[28], high sedentary behavior[29], and the habit of sleeping late[22] among this group, a better understanding of the implications of such behaviors on perceived health is needed. The scarcity of studies addressing the characterization of the reallocation of time between these behaviors and the impact on negative SRH among university students makes this study essential to contribute to the implementation of institutional programs that can favorably guide the use of time to obtain health improvements. Thus, the aim of this study was to examine the effect of isotemporal substitution of physical activity, sedentary, and sleeping time in relation to negative SRH in university students at a public university in the state of Minas Gerais, Brazil.

METHODS

This was a cross-sectional study carried out with information from the first survey of the study: Lifestyle profile and quality of life of students at the Federal University of Triângulo Mineiro (UFTM), located in the city of Uberaba, MG, Brazil. Participants received guidance on the research objectives and signed the Informed Consent Form (ICF). The study received approval from the Ethics Committee (EC) of UFTM (CAAE 77869617.1.0000.5154).

The sample size calculation was based on the number of university students enrolled in the first semester of 2018 in undergraduate courses on-site (N = 5,952). The equation proposed for the calculation was that of Luiz and Magnanini[30], considering the following information: confidence level of 95%, prevalence of 50% due to the survey of different outcomes, and acceptable sampling error of three percentage points. 20% were added for losses and a further 10% for the control of confounding variables in the adjusted analyses, thus the calculated sample was 1,195 university students.

This sample was distributed proportionally to the distribution of the target population among the undergraduate courses (25 courses) and the selection was made by convenience according to the number of students per course. Refusals (university students found, but who were not interested in participating) were set to be replaced. Participants were eligible for participation if they were 18 years of age or older, regardless of gender and physical conditions. Excluded participants were, after tabulating the data, those who reported belonging to online learning courses, who reported entering the institution through a higher education diploma, and who enrolled in technical courses and courses not be-

longing to the headquarters in Uberaba, MG. Information regarding the inclusion and exclusion criteria was available from the ICF and the exclusion was possible due to the questions inserted in the research instrument.

The data collection teams received training in March 2018 and collections took place during the months of April to July 2018 in the classrooms, individually or in groups of up to 30 university students according to the availability of the volunteers. Questions from the HIQL-A (Health Indicators and Quality of Life in Academics) questionnaire were used, an instrument previously tested for validity and reproducibility for application in research with university students[31], and the IPAQ (International Physical Activity Questionnaire, short version), also validated for use with young adults[32], along with sociodemographic and university-related questions to measure information.

For the present study, the dependent variable was SRH, measured through the question: in general, how do you consider your current health status? Possible answers were "very good", "good", "fair", "bad", and "very bad". Answers "regular", "bad", and "very bad" (negative SRH) were used as outcomes for this study. The answer "regular" was included as negative SRH as studies have shown that the risk of mortality and risk-taking behaviors are associated characteristics for people who perceive health at this level[15,33]. The reproducibility level of this measure is kappa = 0.70[31].

The independent variables were estimated by the questions regarding the time spent in physical activity, sitting time, and sleeping time. Physical activity was calculated as the sum of time spent on walking, activities at moderate intensity and at vigorous intensity in a typical week, with the time of practice of physical activities at vigorous intensity multiplied by two[34]. Variables "sitting time" and "sleeping time" were estimated by questions related to a weekday and a weekend day, and

the period of times of the variables per day during the week were calculated as a weighted average, by multiplying the time of the week by five and weekend time by two, divided by seven days. Hours were converted to minutes for each behavior.

The isotemporal substitution approach was used to verify the effects of the reallocation of time spent on physical activity, sitting and sleep times under negative SRH[35,36]. Isotemporal substitution is a model introduced in the epidemiology of physical activity to study the health effects of replacing time spent in one activity by reallocating that time to another. When removing one of the activities from the model, the coefficients of the other activities represent the effect of replacing the time period of the activity removed by the same amount of time of the activities that remained in the model[35,36].

Times spent on each activity was converted into minutes per day. All independent variables were normalized to time constants of 10, 30, and 60 minutes/day. The choice of these amounts of time was due to greater comparability with published studies using isotemporal substitution analysis[37], in addition to the activities investigated in this study being performed for a time greater than 10 minutes.

The variables for confounding control in the adjusted analyses, selected based on a systematic review study with university students[15] were: gender (male and female); marital status (with and without a partner); area of study classified as Health and Other Sciences (Exact and Earth Sciences, Biological Sciences, Engineering, Agricultural Sciences, Social and Applied Sciences, Human Sciences, Letters and Arts)[38]; fruit consumption, such as irregular consumption of up to 4 days a week and regular consumption as 5 or more days a week[39]; consumption of vegetables, referring to irregular consumption of up to 4 days a week and regular consumption as 5 or more

days a week[39]; habit of smoking cigarettes, considering smokers (smoking 1 or more cigarettes per day), ex-smokers (stopped smoking), and non-smokers (never smoked)[40]; level of stress, through the report of positive self-assessment (never and rarely) and negative self-assessment of stress (sometimes, almost always, and always)[41]; reported high cholesterol (yes and no)[42] and body mass index (BMI), classified with BMI ≥ 25 kg/m² for overweight and BMI ≤ 24.9 kg/m² [43] for non overweight[43].

The information was tabulated in Excel, version 2013, and data analyses were performed on SPSS for Windows, version 24. Descriptive analyses included absolute and relative frequencies, mean and standard deviation (SD), and minimum and maximum. The Odds Ratio

(OR) was used as a measure of association, complemented by the 95% confidence interval (95% CI), estimated via binary logistic regression. Initially, health-related behaviors with standardized times (physical activity, sitting time, and sleeping time) were analyzed in isolation in relation to the outcome, with adjustment for control variables. Subsequently, the behaviors were analyzed in a model in total that comprised the simultaneous comparison of all adjusted behaviors with each other, together with the control variables. Finally, an isotemporal analysis was performed, reallocating the time of each behavior to the others, keeping in the analysis the adjustment for the other behaviors and the control variables. The significance level adopted was 5%.

RESULTS

A total of 1,156 university students participated in the study, from which three participants were excluded because they were younger than 18 years old and forty-three because they had a higher education degree, making a final sample of 1,110 university students. There were no losses during data collection. With the number of university students participating in each course, there was no statistical difference between the sample and the target population (data not shown).

The sociodemographic characteristics, relationship with the university, behavioral characteristics, and referred morbidities are presented in Table 1. Most participants were female (61.8%), without a partner (96.1%) and from areas of study not health-related (68.6%). Most university students reported irregular consumption of fruits (75.1%) and vegetables (53.3%), there was also a predominance of university students who never

smoked (83.9%) and who negatively self-rated stress (84.9%). Most reported not having been diagnosed with high cholesterol (86.6%) and 72.2% were not overweight.

The prevalence of negative SRH was 47.3%. Table 2 presents the descriptive analyses of the minutes of health-related activities (physical activity, sitting time, and sleeping time). There was a predominance of sitting time with an average of 497.25 minutes per day. Analyzed separately, it was observed that chances of negative SRH were lower for the behavior of physical activity, with the increase of time in 10, 30, and 60 minutes per day. The increase in sitting time was associated with higher chances of negative SRH (Table 2).

Table 3 presents the simultaneous analysis of health-related behaviors adjusted for each other and for exploratory characteristics. A lower chance of negative SRH was observed by increasing 10, 30 and 60 minutes of physi-

cal activity per day.

The isotemporal substitution models that assesses the reallocation of time at 10, 30, and 60 minutes between behaviors are presented in Table 4. The 10 minutes (OR = 0.979; 95%CI = 0.968-0.991), 30 minutes (OR = 0.939; 95%CI = 0.906-0.974), and 60 minutes (OR = 0.882; 95%CI = 0.821-0.948) substitution of sitting time to physical activity were associated with lower odds of negative SRH. No association was observed with sleep time reallocation (Table 4).

Table 1 – Description of sociodemographic variables, related with the university, behavior and referred morbidities of university students. Uberaba, MG. 2018.

Variables	n	%
Sex		
Female	683	61.8
Male	422	38.2
Marital status		
With partner	43	3.9
Without partner	1.067	96.1
Areqa of study		
Health Sciences	349	31.4
Others	761	68.6
Fruit consumption		
≤ 4 days per week	830	75.1
≥ 5 days per week	275	24.9
Vegetable consumption		
≤ 4 days per week	589	53.3
≥ 5 days per week	516	46.7
Smoking habit		
Never smoked	929	83.9
Ex-smoker	64	5.8
Smoker	114	10.3
Stress level		
Positive	166	15.1
Negative	936	84.9
Referred cholesterol		
Yes	139	13.4
No	895	86.6
Body Mass Index		
Overweight	305	27.8
Not overweight	794	72.2

%: Proportion.

Table 2 – Descriptive analysis of minutes related to health-related behaviors and estimated association in relation to negative health self-assessment in university students. Uberaba, MG. 2018.

Variables	Minutes			Minutes/10min. *	Minutes/30min. *	Minutes/60min. *
	n	Mean (SD)	Min- Máx	OR (95%CI)†,‡	OR (95%CI)†,‡	OR (95%CI)†,‡
Physical Activity	1.065	139.40 (135.5)	0-600	0.986 (0.976-0.997)	0.960 (0.931-0.990)	0.921 (0.866-0.980)
Sitting time	1.099	497.25 (198.4)	0-985.71	1.009 (1.003-1.016)	1.028 (1.008-1.049)	1.057 (1.015-1.101)
Sleeping time	1.084	434.97 (74.18)	154.29-900	1.000 (0.982-1.019)	1.000 (0.946-1.057)	1.001 (0.896-1.118)

SD: Standard deviation; *All variables were divided by a constant of 10, 30, and 60 minutes per day, so an increase or decrease in OR indicated that chances for negative self-rated health were due to an increase of 10, 30, and 60 minutes per day in the behavior; †Effect of the association of isolated behavior in relation to negative self-rated health; ‡Adjusted for sex, marital status, area of study, fruit and vegetable consumption, smoking, stress level, reported cholesterol, and body mass index. OR: Odds Ratio; 95%CI: Confidence interval at 95%.

Table 3 – Association between health-related behaviors and negative health self-assessment of university students. Uberaba, MG. 2018.

Health related behavior§	Model in total 10‖	Model in total 30‖	Model in total 60‖
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Physical activity	0.987 (0.977-0.997)	0.962 (0.932-0.992)	0.925 (0.868-0.985)
Sitting time	1.008 (1.001-1.015)	1.024 (1.003-1.045)	1.048 (1.006-1.093)
Sleeping time	1.000 (0.981-1.019)	0.999 (0.945-1.057)	0.998 (0.892-1.117)

§All variables were divided by a constant of 10, 30, and 60 minutes per day, so an increase or decrease in OR represented chances of negative self-rated health were due to an increase of 10, 30, and 60 minutes per day in activity;
‖Model in total: association effect without substitution of behaviors in relation to negative self-rated health, adjusted for sex, marital status, area of study, fruit and vegetable consumption, cigarette smoking, stress level, reported cholesterol, and body mass index simultaneously; OR = Odds Ratio; 95% CI = 95% Confidence Interval.

Table 4 – Isotemporal substitution models examining the change in physical activity time, sitting time, and sleeping time and the chances of negative self-rated health among university students. Uberaba, MG. 2018.

Variables	Isotemporal replacement model¶	Physical Activity OR (95%CI)	Sitting time OR (95%CI)	Sleeping time OR (95%CI)
	Model 1 – 10 min	Replaced	1.021 (1.009 - 1.034)**	1.013 (0.991 - 1.035)
	Model 2 – 10 min	0.979 (0.968 - 0.991)**	Replaced	0.992 (0.973 - 1.012)
	Model 3 – 10 min	0.987 (0.966 - 1.009)	1.008 (0.989 - 1.028)	Replaced
	Model 1 – 30 min	Replaced	1.065 (1.027 - 1.104)**	1.039 (0.975 - 1.108)
Negative self-rated health	Model 2 – 30 min	0.939 (0.906 - 0.974)**	Replaced	0.976 (0.920 - 1.035)
	Model 3 – 30 min	0.962 (0.903 - 1.026)	1.025 (0.966 - 1.087)	Replaced
	Model 1 – 60 min	Replaced	1.134 (1.055 - 1.219)**	1.080 (0.950 - 1.227)
	Model 2 – 60 min	0.882 (0.821 - 0.948)**	Replaced	0.952 (0.847 - 1.071)
	Model 3 – 60 min	0.926 (0.815 - 1.053)	1.050 (0.933 - 1.181)	Replaced

¶Effect of the association of health-related behaviors in relation to negative health self-assessment. Model 1 = Effect of reallocation of physical activity time to sitting time and sleeping time. Model 2 = Effect of reallocation of sitting time to physical activity time and sleeping time. Model 3 = Effect of reallocation of sleeping time to physical activity time and sitting time. All models were adjusted for sex, marital status, area of study, fruit and vegetable consumption, cigarette smoking, stress level, reported cholesterol, and body mass index. OR = Odds Ratio; 95%CI = 95% Confidence Interval. ** Demonstration of significant relocation associations with p < 0.05 in the Wald test.

DISCUSSION

The main results observed highlighted that the replacement of 10, 30, or 60 minutes per day of sitting time to the respective amount of time on physical activity progressively reduced the chances of negative SRH among university students. Conversely, greater chances of negative SRH were observed when substituting the same times of physical activity to sitting time.

Through the isotemporal substitution approach, it was noted that replacing 10 minutes/day of sitting time with physical activity represents lower chances of negative SRH and, as expected, the increase in OR was progressive with the replacement at 30 and 60 minutes/day. A survey carried out with this group showed that the replacement of 30 minutes/day of screen time in total (computer use in research and leisure, video games, and television) by the practice of physical activity during leisure time per day was associated with positive SRH[14]. Furthermore, in another study, carried out with Canadian adults, replacing 30 minutes of sedentary behavior with moderate to vigorous physical activity was associated with lower chances of poor and regular self-rated health[26]. The result of this study suggests that including, for example, breaks between sedentary behavior to perform physical activities by university students can contribute to a decrease in the perception of negative health levels.

Regarding sitting time, it stands out as a prevalent behavior in the university environment[29] and long periods of this behavior are related to having health problems, such as cardiovascular diseases, obesity, metabolic syndrome, and diabetes mellitus[44]. In this study, there was a predominance of time spent in sedentary behavior (497.25 minutes/day, equivalent to 8.23 hours/day), and this result is possibly related to academic issues, due to demands of activities focused on studies. Analyzed in isolation, each increase in sitting time (10, 30, and 60 minutes/day) was associated with greater chances of negative SRH, which may favor the occurrence of health-related risk factors[44].

The results of the analysis of the model in total showed that the practice of 10, 30, and 60 minutes a day of physical activities independently were associated with lower chances of negative SRH among university students. Evidence related to physical activity is well documented in the literature regarding the protective effect of this behavior on health[45]. It is possible to highlight that the perspective of the minimum time (10 minutes) of physical activity recommended by the World Health Organization[45] corroborates this study, which showed lower chances of negative SRH among university students who practiced physical activities for that the same amount of time. It is understood that the practice of physical activity from a minimum amount of time already favors health benefits[46], which may reflect in a better perception of health.

In this study, there were no associations regarding sleep time, either with the increase or the reallocation of 10, 30, and 60 minutes/day. Sleep is a behavior that is related to an organic need[44] and is essential for physical health as it requires adequate duration and appropriate time[47]. The National Sleep Foundation recommends 7 to 9 hours/day as appropriate sleep duration for young adults, and in some cases 6 to 11 hours/day is acceptable[48]. In this study, it was observed that the average sleep duration of university students was 7.24 hours/day, which represents an adequate range, and both the increase in time in this activity and the relocation to others did

not configure it as determinant for the level of negative health. However, it is important to consider that the co-occurrence of inadequate sleep time, together with the long sitting time and lower levels of physical activity, can significantly contribute to negative SRH[20].

This study has limitations, such as the convenience sample selection, which can cause sampling bias, that is, not everyone has the same chance of being selected for the sample[49]. However, the sample stratification procedure was performed according to the institution's courses, which minimizes selection bias in a single course. The use of self-reported measures to obtain data on physical activity behaviors, sitting time, and sleeping time may present response bias[50], but studies have observed satisfactory levels of validity on the use of the IPAQ questionnaire (short version) to estimate physical activity[51] and sitting time[52], and the HI-QL-A for the measurement of sleep time[53].

As positive points of the study, it is possible to mention the representativeness of the study sample in relation to the institution's courses. Added to this is the new analytical approach (isotemporal substitution modeling) in which the theoretical effects of the substitution of time in one health-related behavior for another are analyzed and represents an alternative to estimate the impact of different behaviors on health outcomes[54]. These new approaches that integrate physical activity time, sedentary behavior, and sleep time become important both for controlling the time spent on daily activities and for the scientific development of the health-related area[55].

CONCLUSION

It is concluded that the replacement of 10, 30, and 60 minutes of sitting time for the same amount of time in physical activity can progressively reduce chances on university students to negatively self-evaluate health, and that, conversely, the reallocation of the same times of physical activity by sitting time, was associated with an increase in chances of negative SRH in this group. Thus, this study can help in the creation of policies at the university that encourage students to spend less time sitting, reallocating time in this behavior for physical activity, thus avoiding health-related issues. This study recommends investigations that use time spent on light physical activity, which would reflect the use of full time (24 hours/day) between behaviors, as well as prospective intervention studies in which results can be examined before and after time is purposefully reallocated, as this study is based on statistical modeling and not on actual substitutions of one activity for another.

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