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# Isolated and combined linkage of insufficient physical activity and excessive sitting time on college students' negatively self-related health

## Asociación aislada y combinada de actividad física insuficiente y tiempo excesivo de estar sentados en la salud autoevaluada negativamente de estudiantes universitarios

## Associação isolada e combinada de atividade física insuficiente e tempo sentado excessivo na autoavaliação negativa da saúde de estudantes universitários

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**Abstract:** The objective of this study was to analyze the isolated and combined linkage of insufficient physical activity and excessive sitting time on negatively self-rated health in university students. This is a cross-sectional study conducted with 418 students from a community university in western Santa Catarina, Brazil. Self-rated health was the dependent variable. Self-reported information on moderate to vigorous physical activity and sitting time was collected through a questionnaire. University students were classified as insufficiently active or with excessive sitting time if they did not meet the recommended guidelines. For the analysis, models were developed that considered physical activity and sitting time in isolation and in combination, using those who did meet the guidelines as a reference. The data was analyzed using Poisson regression, with adjustment for sociodemographic variables and characteristics related to the participants' degree. Results show that most of the participants were women (73.4%) and the average age was 22.9 years (SD = 5.3). Three out of every 10 university students had a negatively self-rated health. In addition, individually, insufficiently active university students and those with excessive sitting time were 1.73 (95% CI = 1.25-2.40) and 1.40 (95% CI = 1.05-1.87) times more likely to report a negatively self-rated health. In the combined analysis, when presenting both risk factors simultaneously, the probability of presenting negatively self-rated health was 2.76 (95% CI = 1.62 – 4.71). College students with insufficient physical activity and excessive sitting time are at a higher risk of negatively self-rated health, particularly when both behaviors are present simultaneously.

**Key words:** lifestyles, physical activity, health of college students, Brazil.

**Resumen:** El objetivo de este estudio fue analizar la asociación aislada y combinada de presentar actividad física insuficiente y tiempo excesivo de estar sentados con la percepción negativa de la

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salud en estudiantes universitarios. Este es un estudio transversal realizado con 418 estudiantes de una universidad comunitaria en el oeste de Santa Catarina, Brasil. La salud autoevaluada fue la variable dependiente. Mediante un cuestionario, se recopilaron datos registrados por los propios informantes sobre la actividad física de moderada a vigorosa y el tiempo de estar sentados. Los estudiantes universitarios fueron clasificados como insuficientemente activos o con tiempo excesivo de estar sentados si no cumplían con las recomendaciones establecidas. Para el análisis, se desarrollaron modelos que consideraban de manera aislada y combinada la actividad física y el tiempo de estar sentados, usando como referencia a quienes cumplían con las recomendaciones. Los datos se analizaron mediante regresión de Poisson, ajustando por variables sociodemográficas y características relacionadas con el grado de los participantes. Los resultados muestran que la mayoría de los participantes eran mujeres (73.4%) y la edad promedio fue de 22.9 años (DE = 5.3). Tres de cada 10 estudiantes universitarios presentaron una percepción negativa de la salud. Además, de manera individual, los estudiantes universitarios insuficientemente activos y aquellos con tiempo excesivo de estar sentados tuvieron, respectivamente, 1.73 (95%IC = 1.25-2.40) y 1.40 (95%IC = 1.05-1.87) veces más probabilidades de tener una percepción negativa de su salud. En el análisis combinado, al presentar ambos factores de riesgo simultáneamente, la probabilidad de tener una percepción negativa de la salud fue de 2.76 (95%IC = 1.62 – 4.71). Los estudiantes universitarios con actividad física insuficiente y tiempo excesivo de estar sentados presentan un mayor riesgo de tener una percepción negativa de la salud, particularmente cuando ambos comportamientos están presentes en forma simultánea.

**Palabras clave:** estilo de vida, actividad física, salud de estudiantes universitarios, Brasil.

**Resumo:** O objetivo deste estudo foi analisar a associação isolada e combinada da atividade física insuficiente e do tempo sentado excessivo com a percepção negativa de saúde em estudantes universitários. Trata-se de um estudo transversal realizado com 418 estudantes de uma universidade comunitária do oeste de Santa Catarina, Brasil. A autoavaliação da saúde foi a variável dependente. Por meio de um questionário, foram coletados dados registrados pelos próprios informantes sobre atividade física moderada a vigorosa e tempo sentado. Os estudantes universitários foram classificados como insuficientemente ativos ou com tempo sentado excessivo caso não atendessem às recomendações estabelecidas. Para a análise, foram desenvolvidos modelos que consideraram a atividade física e o tempo sentado separadamente e combinados, tomando como referência aqueles que cumpriram as recomendações. Os dados foram analisados por meio de regressão de Poisson, com ajuste para variáveis sociodemográficas e características relacionadas com o nível dos participantes. Os resultados mostram que a maioria dos participantes eram mulheres (73,4%) e a idade média foi de 22,9 anos (DP = 5,3). Três em cada 10 universitários tiveram percepção negativa de saúde. Além disso, individualmente, os universitários insuficientemente ativos e aqueles com tempo sentado excessivo tiveram, respectivamente, 1,73 (IC95% = 1,25-2,40) e 1,40 (IC95% = 1,05-1,87) vezes mais chances de ter uma percepção negativa sobre sua saúde. Na análise combinada, quando os dois fatores de risco foram

apresentados simultaneamente, a probabilidade de ter percepção negativa de saúde foi de 2,76 (IC95% = 1,62 – 4,71). Estudantes universitários com atividade física insuficiente e tempo sentado excessivo correm maior risco de ter percepções negativas de saúde, principalmente quando ambos os comportamentos estão presentes simultaneamente.

**Palavras-chave:** estilo de vida, atividade física, saúde de estudantes universitários, Brasil.

## 1. Introduction

The beginning of the academic journey in higher education marks a significant milestone in a student's life, considering the transition from adolescence to adulthood. During this period, an increase in responsibilities and transformations in daily life is observed, which may include the addition of a work schedule, as well as the possibility of moving to another city to study, often resulting in independent living away from family (Abrantes et al., 2022). However, another aspect to consider is the high prevalence of risk behaviors exhibited by university students (Campos et al., 2016; de Sousa et al., 2013), particularly in the advanced stages of undergraduate studies (Brandão et al., 2011; Campos et al., 2016; Cena et al., 2021; Sousa et al., 2021). This, in turn, can negatively influence the self-rated health reported by this population (De Marco et al., 2023; Ferreira et al., 2021).

Self-rated health assessment is a widely used tool in epidemiological studies to evaluate the overall health status of individuals at all stages of life (Brazil, 2022b; Reichert et al., 2012). Although it is a subjective measure, self-rated health has proven to be one of the main predictors of hospitalization and all-cause mortality (Ganna & Ingelsson, 2015; Tavenier et al., 2022; Xiong et al., 2022). This is possibly because individuals who rate their health negatively are more likely to develop comorbidities, whether metabolic or mental (De Marco et al., 2023; Mavaddat et al., 2014). Additionally, these individuals tend to adopt modifiable health risk behaviors, such as insufficient levels of moderate to vigorous physical activity (MVPA), excessive sedentary behavior (e.g. sitting time or screen time), short sleep duration, alcohol consumption, and poor diet (De Marco et al., 2023; Ferreira et al., 2021; Ferreira et al., 2022a; Marco et al., 2023; Sampasa-Kanyinga et al., 2022).

Among these risk behaviors, insufficient levels of MVPA and excessive sedentary behavior stand out as significant public health problems, leading to high economic costs for society (Nguyen et al., 2022; Pinto et al., 2023; Santos et al., 2023). Both behaviors are associated with an increased likelihood of all-cause mortality, the development of chronic diseases, and the worsening of mental health (Ekelund et al., 2016; Pinto et al., 2023; Santos et al., 2023). Although insufficient levels of MVPA and high sedentary behavior share several adverse health consequences, the negative effects of sedentary behavior can manifest even in the presence of high levels of physical activity (Pinto et al., 2023). This highlights the need for specific approaches to reduce sedentary time, in addition to promoting increased physical activity, to improve the overall health of the population.

The practice of physical activity and sedentary time are behavioral elements that require special attention in the university population. Evidence indicates a tendency to have insufficient levels of MVPA and to spend prolonged periods in a sitting position (Ma et al., 2020; Pengpid & Peltzer, 2019), which is associated with a greater likelihood of a negative rated of your health (Ferreira et al., 2022a; Pengpid & Peltzer, 2019).

Therefore, for a more comprehensive understanding of the impact of insufficient levels of MVPA and excessive sedentary behavior on the self-rated health of university students, it is necessary to consider the integration and interrelationship between these behaviors, given that changes in one affect the other (Ross et al., 2020). For example, in a study carried out by (Ferreira et al., 2022a), it was observed that university students who presented two or three risk behaviors (insufficient MVPA, excessive sitting time, and inadequate sleep) had an increase of 39% and 70%, respectively, in the likelihood of reporting a negative self-rated health when compared to those who not exhibiting these risk behaviors. However, when replacing at least 10 minutes of sitting time with MVPA can gradually reduce the chances of a negative self-rated health among university students (Ferreira et al., 2022b).

Given the constant increase in the university student population in Brazil over the years (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira [INEP], 2022a), it is important to investigate how insufficient levels of MVPA and excessive sitting time, both in isolation and in combination, impact the negative self-rated health of this condition. Thus, the present study aims to analyze the isolated and combined effects of insufficient MVPA and excessive sitting time on the negative self-rated health of university students in the western region of Santa Catarina.

## 2. Methods

### Study design

This study is part of the project "General Health Conditions and Lifestyle of Students at the University of Western Santa Catarina (UNOESC) Campus Xanxerê.". It has a cross-sectional design involving university students aged 17 to 65 years, enrolled in undergraduate courses at a community university in the year 2020. We also reported our findings of the study according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria (Vandenbroucke et al., 2014).The study was approved by the UNOESC Research Ethics Committee on November 18, 2019 under CAAE number 23419119.0.0000.5367

### Study participants and data collection procedure

Initially, authorization was sought from the higher education institution to carry out the study with university students. Subsequently, contact was made with the coordinators of each undergraduate course to seek authorization for the collections. The sample was selected by convenience, where all students at the institution were invited to participate in the study, including freshmen. The inclusion criteria were: a) being duly enrolled in an undergraduate course at the

investigated institution; b) sign the Free and Informed Consent Form. All completed questionnaires were stored and tabulated, and individuals with incomplete information of interest to the study were subsequently excluded. The following exclusion criteria were considered: a) Being a special student or a postgraduate student at the university; b) be enrolled on a campus in another city and taking an isolated course at the university's Xanxerê Campus.

Individuals were selected through convenience sampling from a population of 2,100 students enrolled in 17 undergraduate programs, where everyone was invited to participate in the study voluntarily. For the parent project, the sample size was determined using the formula proposed by Luiz & Magnanini (2000). An estimated unknown prevalence of 50%, a confidence level of 95%, and a sampling error of five percentage points. An additional 10% was added to these parameters to account for potential sample losses. This resulted in a minimum sample size of 354 students to ensure the sample's representativeness of the educational institution. Since data collection was conducted remotely using an online questionnaire, all university students were invited to participate via their institutional email. All data in this study were obtained between February and early March, prior to social isolation in Brazil caused by the Covid-19 pandemic.

### Dependent variable

Self-rated health was used as the dependent variable. Students were asked to assess their health using the following question with five response options: "In general, how would you describe your health?" 1-Very Good, 2-Good, 3-Fair, 4-Poor, and 5-Very Poor. For analysis purposes and to facilitate comparison with existing literature, the categories of self-rated health were dichotomized into positive (Very Good, Good) and negative (Fair, Poor, Very Poor), as done in previous studies (Andrade et al., 2019; De Marco et al., 2023; Ferreira et al., 2022a; Loch et al., 2015; Pavão et al., 2013).

### Independent variable

Physical activity level was assessed using the short version of the International Physical Activity Questionnaire (IPAQ), validated for application in Brazilian adults by Matsudo et al. (2001). This questionnaire assesses the number of days and minutes of MVPA practiced during leisure, commuting, work and household chores, considering the week prior to the assessment. Individuals who engaged in less than 150 minutes of moderate activities, 75 minutes of vigorous activities, or an equivalent combination of 150 minutes of moderate and vigorous physical activity per week were classified as insufficiently active (WHO, 2020).

The assessment of sitting time was performed by measuring the time that university students spent sitting on weekdays and weekends in the previous week. This was investigated through the following questions: a) how much total time do you spend sitting on a weekday? and b) how much total time do you spend sitting on a weekend day? (Matsudo et al., 2001). To calculate daily sitting time, the following formula was used: [(Weekday sitting time x 5) + (weekend day sitting time x 2) /7]. The cutoff point for excessive sitting time was based on the Canadian 24-Hour Movement Guidelines, which recommended no more than 8 hours of daily sitting (Ross et al., 2020).

### Adjustment and characterization variables

To characterize university students, sociodemographic information such as sex, age, skin color (white, black, yellow, or brown), marital status (single, married, widowed, or divorced), monthly income, and information about their occupation was collected. For the association analyses, skin color was dichotomized, grouping those with black, yellow or brown skin color and in the other category those with white skin color (Pavão et al., 2013). For monthly income, the gross monthly income of university students was considered in reference to the Brazilian minimum wage of R$1,045.00 in effect in 2020. Participants were asked to choose the option that best reflected their monthly income: No income; less than R$1,045.00; from R$1,045.00 to R$2,090.00; from R$2,090.00 to R$3,135.00; from R$3,135.00 to R$4,180.00; and greater than R$4,180.00. For the regression analysis, the variable was dichotomized into < 2 minimum wages and > than 2 minimum wages (De Marco et al., 2023). To obtain information about the students' occupation, they were asked if they had any paid employment, excluding paid internships, with the answer options "yes" and "no". Next, students were also asked about their participation in paid internships, with the same answer options. Subsequently, both pieces of information were combined into a single variable, with the following categories: "No job or internship", "Have an internship", "Have a job", and "Have a job and an internship".

Information was also collected on the students' undergraduate degree, including the shift of study (day or night), the phase/semester in which they were enrolled, and the course attended. In terms of phase/semester, the undergraduate courses had between 8 and 10 phases, each lasting one semester. The students were asked which phase of the course they were in, and this information was then categorized as follows: first year (1st and 2nd phase), second year (3rd and 4th phase), third year (5th and 6th phase), fourth year (7th and 8th phase) and fifth year (9th and 10th phase). Regarding their degree course, the students had to report which of the 17 courses offered by the university they were enrolled in. Students took part in 14 courses, which were then grouped into areas of scientific knowledge: Health (Physical Education, Nursing, Pharmacy, Psychology, Radiology), Agricultural (Veterinary Medicine), Applied Social (Administration, Architecture, Accounting, Law, Design), Exact and Technological (Civil Engineering, Systems Analysis and Development) and Humanities (Pedagogy).

### Statistical analysis

The data were initially recorded in Microsoft Excel® and later imported into IBM SPSS Statistics version 20.0. A significance level of $p<0.05$ was adopted. Data analysis was conducted using descriptive statistics (frequencies, mean, and standard deviation). The Mann-Whitney U test was used to identify age differences between sexes, while the chi-square test was used to assess differences between categorical variables. To investigate the association of MVPA and sitting time (analyzed as individual variables and the number of simultaneous behaviors adopted) with negative self-rated health, adherence to guidelines was used as the reference category. Crude and adjusted Poisson regression models were applied, with a robust model. In the adjusted model, variables such as sex, age, monthly income, marital status, skin color and graduation phase were included, due to the influence that these variables may exert on the outcome variable (Andrade et al., 2019;

Brazil, 2022b; De Marco et al., 2023; dos Santos et al., 2021; Pavão et al., 2013; Reichert et al., 2012). Prevalence ratios (PRs) and respective confidence intervals (CIs) were estimated. Multicollinearity was tested using linear regression, with predictor variables presenting adequate values of Variance Inflation Factor (VIF) < 2. The quality of the model was assessed using the deviation values and Pearson's chi-square. All models presented values of $p > 0.600$ in both tests, suggesting that there is no significant evidence against the adequacy of the model to the data.

## 3. Results

Of the 2100 university students potentially eligible for the study, 450 participated. Of these, 32 were excluded due to incomplete information on physical activity and sitting time, resulting in a final sample of 418 university students with valid data. The average age of the participants was 22.9 (5.3) years, they were female (73.4%), white skin color (73.7%), and were single (77.3%). Regarding work and income information, the vast majority stated that they received between one and two minimum wages (35.3%) and had a paid job (46.9%).

Table 1 also shows that 31.6% of university students had a negative self-rated health. Furthermore, when analyzing adherence to MVPA guidelines and sitting time in isolation, it was found that 55.7% of students were insufficiently active, while 50.5% had excessive sitting time.

Table 1.
*Sociodemographic characteristics of students at Unoesc campus Xanxerê, in the total sample.*

| Variables | Total Mean (SD) |
|---|---|
| **Age (years)** | 22.9 (5.3) |
| | **n (%)** |
| **Sex** | |
| Men | 111 (26.6) |
| Women | 307 (73.4) |
| **Self-rated health** | |
| Positive | 286 (68.4) |
| Negative | 132 (31.6) |
| **MVPA** | |
| Active | 185 (44.3) |
| Insufficiently active | 233 (55.7) |
| **Sitting time** | |
| Normal | 207 (49.5) |
| Excessive | 211 (50.5) |
| **Skin color** | |
| White | 308 (73.7) |
| Black | 6 (1.4) |
| Brown | 96 (23.0) |
| Yellow | 8 (1.9) |
| **Marital status** | |
| Single | 323 (77.3) |
| Married | 90 (21.5) |
| Widowed or divorced | 5 (1.2) |
| **Monthly income (**MW) | |
| No income | 135 (32.3) |
| Less than 1 | 96 (23.0) |
| From 1 to 2 | 147 (35.2) |
| Between 2 and | 30 (7.2) |
| More than 3 | 10 (2.4) |
| **Job information** | |
| No job or internship | 148 (35.4) |
| Have an internship | 45 (10.8) |
| Have a Job | 196 (46.9) |
| Have a job and an internship | 29 (6.9) |

Source: the authors.

From the results presented in Table 2, it is possible to observe characteristics related to the participants' undergraduate course. In general, most participants were in the first or second phase of their undergraduate studies (28.7%), their classes were at night (50.5%), and they were in the health sciences area (45.5%).

Table 2.
*Characteristics related to graduation and time of study of university students at UNOESC campus Xanxerê, in the total sample.*

| Variables | Total n = 418 n (%) |
|---|---|
| **Study period** | |
| First year | 120 (28.7) |
| Second year | 81 (19.4) |
| Third year | 46 (11.0) |
| Fourth year | 99 (23.7) |
| Fifth year | 72 (17.2) |
| **Class shift** | |
| Daytime | 207 (49.5) |
| Nocturnal | 211 (50.5) |
| **Area of scientific knowledge** | |
| Health | 190 (45.5) |
| Agricultural | 17 (4.1) |
| Applied Social | 102 (24.4) |
| Exact and Technological | 84 (20.1) |
| Humanities | 25 (6.0) |

Source: the authors.

Overall, 25.4% of university students were insufficiently active, failing to meet the recommendations for MVPA, while 20.1% had excessive sitting time. In addition, 30.4% did not meet the guidelines for both MVPA and sitting time, and only 24.1% of students managed to meet both recommendations (Figure 1).

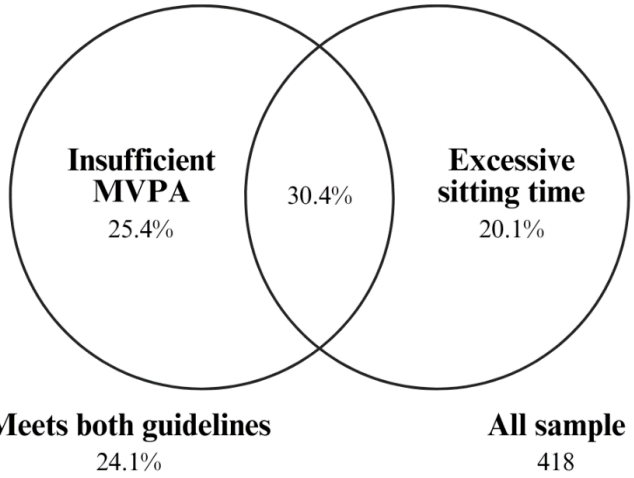


*Figure 1*. Combined prevalence of college students who do not meet the MVPA and sitting time guidelines. Source: the authors.

In Table 3, the crude analysis showed that university students who did not comply with the MVPA and sitting time recommendations had a PR of 1.83 and 1.46, respectively, for reporting a negative self-rated health, when these behaviors were analyzed in isolation. In addition, those who did not simultaneously meet both guidelines had a PR of 3.01 for reporting negative self-rated health. In the adjusted analysis, all the associations remained significant. Considering the behaviors in isolation, non-compliance with the MVPA and sitting time guidelines resulted in a PR increase of 1.73 and 1.40, respectively. In addition, students who did not simultaneously comply with both guidelines had a PR of 2.76 for reporting a negative self-rated health.

Table 3.
*Isolated and combined associations of insufficient MVPA and excessive sitting time with negative self-rated health*

| Variables | Negative self-rated health | |
|---|---|---|
| | Crude PR (95%CI) | Adjusted† PR (95%CI)* |
| **MVPA** | | |
| Active | 1 | 1 |
| Insufficiently active | 1.83 (1.33 – 2.51) | 1.73 (1.25 – 2.40) |
| **Sitting time** | | |
| Normal | 1 | 1 |
| Excessive | 1.46 (1.09 – 1.96) | 1.40 (1.05 – 1.87) |
| **Combined factors** | | |
| No factor | 1 | 1 |
| 1 factor | 2.47 (1.46 – 4.17) | 2.34 (1.38 – 3.96) |
| 2 factors | 3.01 (1.46 – 4.17) | 2.76 (1.62 – 4.71) |

†: Adjusted for sex, age, monthly income, marital status, skin color, monthly income, study shift and graduation phase, PR: Prevalence Ratio; 95%CI: 95% confidence interval. Source: the authors.

## 4. Discussion

The focus of the present study was to analyze the isolated and combined association of insufficient MVPA and excessive sitting time with the self-rated negative health of college students from a community institution. In isolation, not meeting the MVPA and sitting time recommendations was associated with an increased likelihood of college students presenting a negative self-rated health. Furthermore, when these risk behaviors (insufficient MVPA and excessive sitting time) were analyzed in combination, an increase in the likelihood of negative self-rated health among college students was observed.

Regarding the association of insufficient MVPA with the negative self-rated health of university students in both sexes, the literature has already shown that low levels of MVPA negatively affect the self-rated health in this population (De Marco et al., 2023; Ferreira et al., 2021). This association corroborates the findings of Peersman et al. (2012), who observed that younger age groups tend to consider mainly behavioral aspects when estimating their health status. Furthermore, it should be noted that those who reported negative changes in the time devoted to

leisure physical activities are more likely to report a negative self-rated health compared to those who maintain adequate levels of physical activity (Andrade et al., 2019).

Regular physical activity has various social, physio-psychological benefits, and it improves overall quality of life in the population (Loch et al., 2015; Posadzki et al., 2020; Warburton & Bredin, 2019). This results in a dose-response effect, where the reduction in the risk of mortality can vary from 20% to 30%, and it also has a dose-dependent effect, influencing various health-related outcomes (Warburton & Bredin, 2019). Based on the above aspects, it is understandable that university students with insufficient levels of MVPA are more likely to report a negative self-rated health. This is particularly relevant when considering that insufficient physical activity is a contributing factor to more than 35 chronic diseases and conditions, accelerating the process of biological aging and resulting in physiological and cognitive declines (Booth et al., 2017).

Excessive sitting time has been shown to increase the likelihood of college students having negative self-rated health, in line with previous studies conducted in pediatric (Tebar et al., 2021) and adult (Jones et al., 2016) populations. This effect can be explained by the physiological changes induced by excessive sedentary behavior, which have a deleterious impact on the body (Pinto et al., 2023). For example, prolonged sitting is associated with an increased risk of developing obesity, chronic and metabolic diseases (Dunstan et al., 2021; Pinto et al., 2023), premature biological aging (Raffin et al., 2023), declines in mental health (Rodriguez-Ayllon et al., 2019), and increased all-cause mortality (Ekelund et al., 2016).

In the present study, the combination of these risk factors, insufficient MVPA and excessive sitting time, was associated with an increase in the likelihood of university students' negative self-rated health. It has been observed that university students who engage in higher levels of MVPA and spend less time in front of screens have lower risks of having impaired sleep quality and compromised physiological, psychological and social health, compared to their peers who adopt risky behaviors (Ma et al., 2020). In addition, university students who do not meet any 24-hour behavior guidelines (MVPA, sedentary behavior and sleep duration) are 70% more likely to report a negative self-rated health (Ferreira et al., 2022a). On the other hand, progressive reductions in the risks of negative self-rated health were observed with a decrease in sitting time and an increase in MVPA (Ferreira et al., 2022b).

In light of these findings, and considering the literature that reveals a high prevalence of co-occurrence of risk factors and their adverse effects on the development of cardiovascular diseases and mortality (Uddin et al., 2020; Zhang et al., 2021), it is understandable that university students are more likely to report a negative self-rated health when they present both risk behaviors simultaneously, compared to the presence of these behaviors in isolation. This phenomenon can be attributed to the physiological and psychological impairments associated with both insufficient MVPA and excessive sedentary behavior.

These aspects demonstrate the need to jointly consider how behaviors such as physical activity and sitting time impact health (Ross et al., 2020). Several studies have highlighted the importance of interrupting and reducing sedentary behavior through physical activity, regardless of intensity, to minimize the harmful effects of excessive sedentary lifestyle (Dunstan et al., 2021; Hwang et al., 2022; Pinto et al., 2023). These detrimental effects occur even in the presence of

high levels of physical activity and may even cancel out the benefits provided by exercise (Dunstan et al., 2021; Pinto et al., 2023). Given the inverse relationship between time spent in sedentary behavior and physical activity (Mansoubi et al., 2014), it is essential to implement interventions aimed at gradually interrupting and reducing the total time spent in sedentary behavior, promoting a more active lifestyle (Dunstan et al., 2021; Hwang et al., 2022; Pinto et al., 2023).

In this study, the analyses were adjusted for various sociodemographic variables (sex, age, monthly income, marital status, skin color) and factors related to graduation (study shift and graduation stage). Regarding sex, women tend to have a higher prevalence of negative self-rated health, possibly because they are more discerning about their health in general. In contrast, men often consider themselves healthy as long as they manage to maintain functionality in daily activities (Pavão et al., 2013; Peersman et al., 2012). As for age, there is an increase in the prevalence of negative self-rated health with advancing age (Brazil, 2022b; Pavão et al., 2013; Reichert et al., 2012). Younger individuals tend to consider negative health behaviors in their self-assessment, while older people prioritize physical health problems and the need for medical care (Peersman et al., 2012). Regarding skin color, white-skinned people generally have better socioeconomic conditions, greater access to health services and a lower prevalence of risk behaviors (Pavão et al., 2013; Reichert et al., 2012). In addition, monthly income is negatively associated with self-rated health (Pavão et al., 2013; Reichert et al., 2012), since an individual's income is an important social determinant, significantly influencing access to health and healthy lifestyle habits, which contributes to better self-rated health. As for marital status, married people tend to have a better general health picture than single, divorced or widowed people (Robards et al., 2012). Regarding academic aspects, evening students and those at more advanced stages of their course tend to adopt more inappropriate health behaviors and have more health problems (Brandão et al., 2011; dos Santos et al., 2021). Demonstrating the need for analyses with appropriate adjustments when considering how behavioral aspects can affect the self-rated health of the university students investigated in the present study.

This study has important limitations and strengths. Among the limitations are the cross-sectional design, which prevents causal inference, and self-report data collection, which may be subject to memory bias and overestimation of MVPA and underestimation of participants' reported sitting time. The lack of information on university students' sleep limits the complete analysis of 24-hour movement behaviors, recognized for their relevance to health (Ross et al., 2020). In addition, the data were collected before the COVID-19 pandemic, which requires caution in interpreting the results in light of the lifestyle changes that followed. As a strong point, the study contributes to understanding the combined impact of risk behaviors, such as insufficient MVPA and excessive sitting time, on the self-rated health of university students. In addition, the representative sample of the university population allows for a comprehensive understanding of health aspects at the institution and in the western region of Santa Catarina, Brazil, where there is a lack of similar studies.

It is recommended that future studies continue to explore how the combination of risk behaviors affects self-rated health, including the variable of sleep in the combined effect. Additionally, longitudinal studies are needed in which university students can be followed

throughout the entire graduation period, allowing for an understanding of possible behavioral changes that impact self-rated health and enable the identification of causality in the variables of combined effect. This type of research can provide valuable insights into how behaviors over time influence the health perceived by university students.

## 5. Conclusion

This study shows that insufficient MVPA and excessive sitting time, when analyzed in isolation, are associated with a greater likelihood of negative self-rated health among university students. In addition, the simultaneous presence of these risk behaviors seems to aggravate this association, reinforcing the need for interventions that address both increasing physical activity and reducing sitting time to improve health in this population.

### Practical implications

The practical implications of these results are vast and far-reaching, spanning various domains such as public health, education, and policy formulation. These findings underscore the urgency of implementing interventions aimed at promoting physical activity and reducing sedentary behavior among university students, with the goal of enhancing not only their perceived health but also their overall physical and mental well-being. Effective strategies may include the establishment of physical exercise programs within academic settings, the adoption of institutional policies that foster a more active campus culture, and educational campaigns about the health risks associated with sedentary lifestyles.

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**A-**Financing, **B-**Study design, **C-**Data collection, **D-**Statistical analysis and interpretation of results, **E-**Manuscript preparation

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