

# Age, skin color, self-rated health, and depression associated with co-occurrence of obesogenic behaviors in university students: a cross-sectional study

Bruna Carolina Rafael Barbosa<sup>I</sup>, Magda do Carmo Parajára<sup>II</sup>, Waléria de Paula<sup>III</sup>, Elaine Leandro Machado<sup>IV</sup>, Adriana Lúcia Meireles<sup>V</sup>

Universidade Federal de Ouro Preto (UFOP), Ouro Preto (MG), Brazil

<sup>I</sup>MSc. Doctoral Student, Postgraduate Program in Health and Nutrition, School of Nutrition, Universidade Federal de Ouro Preto (UFOP), Ouro Preto (MG), Brazil.

<https://orcid.org/0000-0002-3729-1847>

<sup>II</sup>MSc. Doctoral Student, Postgraduate Program in Health and Nutrition, School of Nutrition, Universidade Federal de Ouro Preto (UFOP), Ouro Preto (MG), Brazil.

<https://orcid.org/0000-0001-7019-1365>

<sup>III</sup>MSc. Doctoral Student, Postgraduate Program on Pharmaceutical Sciences, School of Pharmacy, Universidade Federal de Ouro Preto (UFOP), Ouro Preto (MG), Brazil.

<https://orcid.org/0000-0002-9438-7343>

<sup>IV</sup>PhD. Professor, Department of Preventive and Social Medicine, Faculty of Medicine, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte (MG), Brazil.

<https://orcid.org/0000-0002-3226-3476>

<sup>V</sup>PhD. Professor, Department of Clinical and Social Nutrition, School of Nutrition, Universidade Federal de Ouro Preto (UFOP), Ouro Preto (MG), Brazil.

<https://orcid.org/0000-0002-1447-953X>

## KEYWORDS (MeSH terms):

Obesity.  
Health risk behaviors.  
Students.  
Risk factors.  
Cross-sectional studies.

## AUTHORS' KEYWORDS:

Obesogenic behavior.  
University students.  
Clustering.

## ABSTRACT

**BACKGROUND:** The university context plays an important role in the health-disease process since students are potentially vulnerable to obesogenic behaviors that can influence long-term health.

**OBJECTIVE:** To estimate the prevalence of and factors associated with the co-occurrence of obesogenic behaviors among university students.

**DESIGN AND SETTING:** This was a cross-sectional study at a Brazilian public university.

**METHODS:** This study was conducted with all university students in the first and second semesters of 2019 at Universidade Federal de Ouro Preto, Minas Gerais, Brazil. Data were collected between April and September 2019, using a self-administered questionnaire. The outcome was the co-occurrence of obesogenic behaviors, measured as the sum of three risk behaviors: inadequate eating practices, leisure-time physical inactivity, and sedentary behavior. A Venn diagram was used to evaluate the simultaneous occurrence of risk behaviors. Pearson's chi-square test and multivariate logistic regression were used for statistical analyses.

**RESULTS:** A total of 351 students participated in the study. Inadequate eating practices constituted the most prevalent isolated risk behavior (80.6%), which was also the most prevalent when combined with sedentary behavior (23.6%). University students aged 20 years or younger, with non-white skin color, poor self-rated health, and symptoms of depression had increased chances of simultaneous occurrence of obesogenic behaviors.

**CONCLUSION:** These findings highlight the importance of developing and implementing actions to reduce combined obesogenic behaviors in the university environment. Institutions should focus on creating an environment that promotes health-protective behaviors such as physical activity and healthy eating.

## INTRODUCTION

The prevalence of obesity has increased rapidly in recent decades in both developed and developing countries, reaching the status of a global pandemic. This condition is characterized as both a disease and a risk factor for other chronic non-communicable diseases (NCDs). The etiology of this condition is multifactorial, resulting from a complex interaction between genetic, individual, sociocultural, economic, environmental, and behavioral factors. Epidemiological studies have demonstrated the relationship between important risk factors associated with this morbidity, which represents one of the biggest public health problems today.<sup>1-5</sup>

Many health risk behaviors, such as inadequate eating practices, low levels of physical activity, and sedentary behavior (SB), are considered independent risk factors for being overweight, contributing to increased morbidity and mortality due to NCDs.<sup>6-8</sup> However, exposure to these risk factors does not occur in an isolated manner<sup>9</sup> but in a group or simultaneously, increasing the risk of becoming overweight and obese.<sup>10,11</sup>

Although studies have evaluated the aggregation of multiple health risk behaviors, especially in the general adult population,<sup>12</sup> few studies have focused on university students.<sup>13,14</sup> University enrollment represents a period of health risk for young adults, as it results in numerous changes in the student's life, including increased opportunities to initiate and establish unhealthy behaviors that favor weight gain.<sup>15</sup> Additionally, it is observed that other factors are associated with obesogenic behaviors among university students during academic life, with emphasis on those related to sociodemographic, individual, social, and environmental characteristics.<sup>16</sup>

Understanding potentially obesogenic behavioral risk factors among university students is imperative for identifying more susceptible groups and recognizing the health effects of these factors, to facilitate the development of prevention and health promotion strategies targeted at the university environment. Additionally, this information can contribute to more effective public policies to reduce the rates of obesity- and overweight-related NCDs.

## OBJECTIVE

This study therefore aimed to estimate the prevalence of co-occurrence of obesogenic behaviors and their associated factors in university students.

## METHODS

### Study design and population

This cross-sectional study was integrated with a project on anxiety and depression among university students titled “Symptoms of Anxiety and Depression among University Students of Minas Gerais: a longitudinal study” (Projeto sobre Ansiedade e Depressão em Universitários - PADu). This study was approved by the Research Ethics Committee of the Universidade Federal de Ouro Preto (UFOP) under CAAE no. 19467919.5.0000.5150 on December 19, 2019.

PADu is a longitudinal study conducted with university students entering undergraduate courses offered at the campi of Ouro Preto and Mariana of the UFOP. Data will be collected at three different time points (T0—in the first semester of the undergraduate course; T1—after attending two years; T2—after attending four years) to verify behavioral changes during academic life. For the present study, data from the baseline (T0) were used.

The study population included all university students entering the first and second semesters in the 2019 undergraduate courses in architecture and urbanism, performing arts, law, physical education, civil engineering, production engineering, geological engineering, pharmacy, history, journalism, mathematics, medicine, nutrition, and pedagogy. The students’ lists were made available through the UFOP’s teaching sections.

Students who met the following inclusion criteria participated in the research: regularly enrolled in the first period of the undergraduate courses evaluated in the study and aged 18 years or older.

The PADu sample comprised 355 university students. However, the final sample of this study consisted of 351 university students, since four participants did not answer all the questions related to the co-occurrence of obesogenic behaviors.

### Data collection

Data were collected between April and September 2019 by project members who were previously trained to apply the instrument

and clarify possible doubts of the students. A pilot study was conducted with students attending the eighth period of the nutrition course in the second semester of 2018 who would therefore not participate in the sample.

The questionnaires were administered during class hours, after taking prior appointments, and the teacher’s presence in each selected course. The researchers oriented the university students about the study, risks, and benefits. They were also informed that their participation was voluntary and anonymous. Those who agreed to participate signed the informed consent form and answered a questionnaire consisting of socioeconomic characteristics, lifestyle habits, and health conditions.

### Variables of the study

The outcome variable (co-occurrence of obesogenic behaviors) was obtained from the sum of three risk behaviors: inadequate eating practices, leisure-time physical inactivity, and SB. The responses were categorized as none to three obesogenic behaviors. These behaviors are justified because they are considered health risk factors and are associated with the most significant burden of NCDs and mortality.<sup>17</sup>

The variable “inadequate eating practices” was obtained through a scale developed and validated by Gabe and Jaime for adults, which measures adherence to healthy eating practices based on the recommendations of the second edition of the Food Guide for the Brazilian Population.<sup>18,19</sup> For classification purposes, the cut-off points proposed by Gabe and Jaime were used, wherein eating practices were classified as “inadequate” when the sum of the individual scores assigned to the responses for each alternative resulted in a score of up to 31 points, at “risk” when the score was between 32 and 41 points, and “adequate” when it was greater than 41 points.<sup>20,21</sup> Subsequently, for the present study, eating practices were recategorized as “adequate” and “inadequate.”

Leisure-time physical inactivity was assessed using the study Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), with questions such as: “In the last three months, did you practice any physical exercise or sport? (Do not consider physical therapy).”<sup>22</sup> Participants who answered “no” were classified as “inactive in leisure time,” and those who answered “yes” were considered “active in leisure time.”

SB was included in the study because a growing number of studies characterize it as a health risk factor, different from and independent of physical inactivity, and associated with the occurrence of adverse health effects, such as metabolic syndrome.<sup>9,23</sup> SB was determined in the questionnaire using the following question: “In your free time, that is, when you are not studying or working, how much time (in hours) do you dedicate to using the cell phone, television, computer, or tablet?” This question was adapted from two questions from VIGITEL.<sup>22</sup> For each of the screen types

evaluated, eight answers were possible: “I don’t use,” “less than an hour,” “between one to two hours,” “between two to three hours,” “between four to five hours,” “between five to six hours,” and “more than six hours.” For analysis purposes, SB was analyzed as a continuous variable and responses were coded as 0, 0.5, 1.5, 2.5, 3.5, 4.5, 5.5, and 6.5 hours, respectively. Subsequently, the responses of the time spent on each type of screen were summed, and the classification of SB was established according to the median. University students with screen time  $\leq 6$  h were classified as “non-sedentary,” while those with screen time  $> 6$  h were considered “sedentary.”

The explanatory variables included in this study were grouped into two domains: sociodemographic characteristics and health conditions. The variables assessed in the sociodemographic domain included sex (male and female), age ( $\leq 20$  years and  $> 20$  years), skin color (white and non-white—yellow, brown, mulatto, or black), sexual orientation (heterosexual and others—homosexual, bisexual, or asexual), marital status (single and others—married, stable union, widowed, or divorced), and total monthly family income ( $<$  three minimum wages and  $\geq$  three minimum wages). The wage value considered in this study refers to the minimum wage in force in Brazil in 2019 (R\$ 998.00). The sociodemographic domain comprised the following variables: housing (without and with family members), area of knowledge (life sciences, exact sciences, humanities, and social and applied sciences), and work (no and yes).

In the health condition domain, the following variables were evaluated: self-rated health, categorized as “good” (good and very good) and “bad” (regular, bad, and very bad); anthropometric profile (not overweight or overweight); use of medication for chronic diseases (no and yes); anxiety symptoms (no and yes); depression symptoms (no and yes); and stress symptoms (no and yes).

The anthropometric profile was evaluated by calculating the body mass index (BMI) through the anthropometric measurements of weight and height, self-reported by the participants. The classification was made according to the BMI reference values established by the World Health Organization for adults<sup>24</sup> and adolescents.<sup>25</sup> Individuals classified as underweight and eutrophic ( $\text{BMI} < 24.9 \text{ kg/m}^2$ ) were grouped in the “not overweight” category and those classified as overweight and obese ( $\text{BMI} \geq 25 \text{ kg/m}^2$ ) in the “overweight” category. Additional details on the anthropometric profile classification methodology can be found in a previous publication.<sup>26</sup>

The variables “anxiety symptoms,” “depression symptoms,” and “stress symptoms” were obtained through the reduced version of the Depression Anxiety Stress Scale-21 (DASS-21).<sup>27</sup> The scale is composed of a set of three subscales, designed to estimate in a self-reported way the symptoms of anxiety, depression, and stress in the week before data collection. The response scale to the items is a four-point Likert scale ranging from 0 (not applicable) to 3 (applicable most of the time), generating scores that allow the classification of anxiety, depression, and stress symptoms as

“normal,” “mild,” “moderate,” “severe,” and “extremely severe.” In the present study, symptoms of mental disorders were re-classified as absence (“no”; normal and mild) and presence (“yes”; moderate, severe, and extremely severe).

### Statistical analysis

The variables were descriptively analyzed using frequency distribution. A Venn diagram was used to represent the simultaneous occurrence of obesogenic behaviors among the evaluated university students. This representation method allows for the comparison and visualization of the overlap and differences among the datasets being analyzed based on the intersections of the graphical shapes.<sup>28,29</sup>

Initially, the chi-square test was performed between the explanatory variables and the co-occurrence of obesogenic behaviors, and those with a P value  $< 0.20$  in the bivariate analysis were included in the multivariate model. Multivariate logistic regression was used to verify the association between the co-occurrence of obesogenic behaviors and explanatory variables. In this analysis phase, three models were structured to represent the co-occurrence of the obesogenic behaviors evaluated: Models 1, 2, and 3 included no behavior versus one behavior, no behavior versus two behaviors, and no behavior versus three behaviors, respectively. For this, we used a reference category for university students with no obesogenic behavior versus the number of obesogenic behaviors (1, 2, or 3). To select sociodemographic and health condition variables, the backward method was adopted, and only the variables that presented a P value of  $< 0.05$  remained in the multivariate model. All the models were adjusted for the variable “sex.” The odds ratio (OR) was used to measure the association with the respective 95% confidence intervals (95% CI). The level of statistical significance was 5%. The analyses were performed using Stata version 13.0 (Stata Corporation, College Station, Texas, United States).

### RESULTS

Of the 351 university students included in this study, 57.6% were female and 65.8% were 20 years or younger, ranging from 18 to 31 years. Most participants self-reported their color or race as white (51.1%), single (95.4%), heterosexual (79.5%), living without family members (66.4%), and not employed (89.2%). Regarding family income, slightly more than half (56.7%) of the students reported a family income higher than or equal to three minimum wages. Regarding the distribution by area of knowledge, 41.0% were from life sciences courses, 34.5% from the humanities and social and applied sciences, and 24.5% from the exact sciences (Table 1).

Regarding health conditions, 41.0% of the university students self-rated their health as bad, 22.3% were overweight, and 13.7% reported using medications for chronic diseases. Anxiety, depression, and stress

**Table 1.** Number of obesogenic behaviors in university students entering the Universidade Federal de Ouro Preto in 2019, according to sociodemographic characteristics and health conditions. Ouro Preto, Minas Gerais, 2019 (n = 351)

| Variables  | n   | %    | % of obesogenic behaviors |      |      |      | P value*          |
|--|-----|------|---------------------------|------|------|------|-------------------|
|  |     |      | 0                         | 1    | 2    | 3    |                   |
| <b>Sex</b>   |     |      |                           |      |      |      |                   |
| Male   | 149 | 42.4 | 8.0                       | 40.3 | 38.3 | 13.4 | <b>0.013</b>      |
| Female   | 202 | 57.6 | 10.9                      | 24.7 | 43.1 | 21.3 |                   |
| <b>Age (n = 348)</b>                                 |     |      |                           |      |      |      |                   |
| ≤ 20 years   | 229 | 65.8 | 6.5                       | 33.6 | 41.1 | 18.8 | <b>0.040</b>      |
| > 20 years   | 119 | 34.2 | 16.0                      | 27.7 | 40.3 | 16.0 |                   |
| <b>Skin color (n = 350)</b>                          |     |      |                           |      |      |      |                   |
| White  | 179 | 51.1 | 14.5                      | 31.3 | 36.9 | 17.3 | <b>0.015</b>      |
| Non-white (yellow, brown, mulatto, or black)         | 171 | 48.9 | 4.7                       | 31.0 | 45.6 | 18.7 |                   |
| <b>Sexual orientation</b>                            |     |      |                           |      |      |      |                   |
| Heterosexual   | 279 | 79.5 | 9.7                       | 32.3 | 41.2 | 16.8 | 0.729             |
| Others (homosexual, bisexual, or asexual)            | 72  | 20.5 | 9.7                       | 27.8 | 40.3 | 22.2 |                   |
| <b>Marital status</b>                                |     |      |                           |      |      |      |                   |
| Single   | 335 | 95.4 | 9.3                       | 31.6 | 40.9 | 18.2 | 0.584             |
| Others (married, stable union, widowed, or divorced) | 16  | 4.6  | 18.7                      | 25.0 | 43.8 | 12.5 |                   |
| <b>Total monthly family income**</b>                 |     |      |                           |      |      |      |                   |
| < 3 minimum wages                                    | 152 | 43.3 | 5.9                       | 35.5 | 38.2 | 20.4 | 0.077             |
| ≥ 3 minimum wages                                    | 199 | 56.7 | 12.6                      | 28.1 | 43.2 | 16.1 |                   |
| <b>Housing</b>                                       |     |      |                           |      |      |      |                   |
| Without family members                               | 233 | 66.4 | 9.9                       | 35.6 | 38.2 | 16.3 | 0.091             |
| With family members                                  | 118 | 33.6 | 9.3                       | 22.9 | 46.6 | 21.2 |                   |
| <b>Area of knowledge</b>                             |     |      |                           |      |      |      |                   |
| Life Sciences  | 144 | 41.0 | 11.1                      | 31.2 | 41.0 | 16.7 | 0.365             |
| Exact Sciences                                       | 86  | 24.5 | 12.8                      | 33.7 | 40.7 | 12.8 |                   |
| Humanities and Social and Applied Sciences           | 121 | 34.5 | 5.8                       | 29.8 | 41.3 | 23.1 |                   |
| <b>Work</b>  |     |      |                           |      |      |      |                   |
| No   | 313 | 89.2 | 10.5                      | 32.0 | 39.6 | 17.9 | 0.268             |
| Yes  | 38  | 10.8 | 2.6                       | 26.3 | 52.7 | 18.4 |                   |
| <b>Self-rated health</b>                             |     |      |                           |      |      |      |                   |
| Good (very good and good)                            | 207 | 59.0 | 12.6                      | 33.3 | 40.1 | 14.0 | <b>0.024</b>      |
| Bad (regular, bad, and very bad)                     | 144 | 41.0 | 5.6                       | 28.5 | 42.3 | 23.6 |                   |
| <b>Anthropometric profile (n = 346)</b>              |     |      |                           |      |      |      |                   |
| Not overweight                                       | 269 | 77.7 | 10.4                      | 30.9 | 39.4 | 19.3 | 0.365             |
| Overweight   | 77  | 22.3 | 6.5                       | 35.1 | 45.4 | 13.0 |                   |
| <b>Use of medication for chronic diseases</b>        |     |      |                           |      |      |      |                   |
| No   | 303 | 86.3 | 9.9                       | 32.7 | 39.9 | 17.5 | 0.519             |
| Yes  | 48  | 13.7 | 8.3                       | 22.9 | 47.9 | 20.9 |                   |
| <b>Anxiety symptoms (n = 350)</b>                    |     |      |                           |      |      |      |                   |
| No   | 201 | 57.4 | 11.9                      | 32.8 | 44.8 | 10.5 | <b>&lt; 0.001</b> |
| Yes  | 149 | 42.6 | 6.7                       | 28.9 | 36.2 | 28.2 |                   |
| <b>Depression symptoms (n = 349)</b>                 |     |      |                           |      |      |      |                   |
| No   | 232 | 66.5 | 12.1                      | 32.3 | 44.4 | 11.2 | <b>&lt; 0.001</b> |
| Yes  | 117 | 33.5 | 5.1                       | 28.2 | 35.1 | 31.6 |                   |
| <b>Stress symptoms (n = 349)</b>                     |     |      |                           |      |      |      |                   |
| No   | 222 | 63.6 | 13.1                      | 32.4 | 41.9 | 12.6 | <b>0.001</b>      |
| Yes  | 127 | 36.4 | 3.9                       | 28.3 | 40.2 | 27.6 |                   |

\*P value obtained using Pearson's Chi-Square test; \*\*The minimum wage in force in Brazil in 2019 = R\$ 998.00.

In bold: the statistically significant variables in the bivariate analysis.

symptoms were observed to be 42.6%, 33.5%, and 36.4% of the interviewed university students, respectively (Table 1).

Regarding isolation, the most prevalent obesogenic behavior was inadequate eating practices (80.6%; 95% CI: 76.5–84.8%), followed by SB (49.2%; 95% CI: 44.0–54.5%) and leisure-time physical inactivity (37.3%; 95% CI: 32.2–42.4%).

Figure 1 shows the co-occurrence of obesogenic behavior. The adoption of inadequate eating practices and SB (23.6%) was observed to be the most prevalent combination of risk behaviors among students, followed by inadequate eating practices, leisure-time physical inactivity, and SB (17.9%), and inadequate eating practices and leisure-time physical inactivity (15.7%). The absence of risk factors was observed in 9.7% of university students.

The prevalence distribution of obesogenic behaviors according to sociodemographic characteristics and health conditions is presented in Table 1. In the bivariate analysis, sex, age, skin color, self-rated health, anxiety, depression, and stress symptoms remained associated with the co-occurrence of obesogenic behaviors among university students.

Table 2 presents the results of the multivariate analysis. In the final adjusted models, the following variables maintained a significant association (P value < 0.05) with the co-occurrence of obesogenic behaviors: age, skin color, self-rated health, and depression symptoms. Age and skin color remained associated, in the three evaluation models.

In model 1 (no behavior versus one behavior), individuals aged 20 years or younger [OR: 3.68 (95% CI: 1.58–8.59)] and those who reported colored skin [OR: 3.09 (95% CI: 1.23–7.74)] were more likely to have obesogenic behavior. In model 2 (no behavior versus two behaviors), students who were 20 years or younger [OR: 2.77 (95% CI: 1.23–6.26)], colored skin [OR: 4.61 (95% CI: 1.88–11.31)], and self-rated their health as bad [OR: 2.70 (95% CI: 1.09–6.71)] were more likely to have two obesogenic behaviors simultaneously. In model 3 (no behaviors versus three behaviors), those aged 20 years or younger [OR: 3.34 (95% CI: 1.23–9.05)], colored skin [OR: 3.31 (95% CI: 1.15–9.58)], and reported symptoms of depression [OR: 6.15 (95% CI: 2.10–18.05)] had an increased chance of having three obesogenic behaviors.

### DISCUSSION

The findings of this study indicate that obesogenic behaviors are highly prevalent among university students and tend to co-occur, with more than 80.0% of students presenting at least one obesogenic behavior and 17.9% presenting three behaviors simultaneously. We found a higher chance of one or more obesogenic behaviors in students aged 20 years or younger who self-reported colored skin, self-rated their health as bad, and reported symptoms of depression.

Adopting inadequate eating practices was the single most prevalent risk behavior among university students and was associated

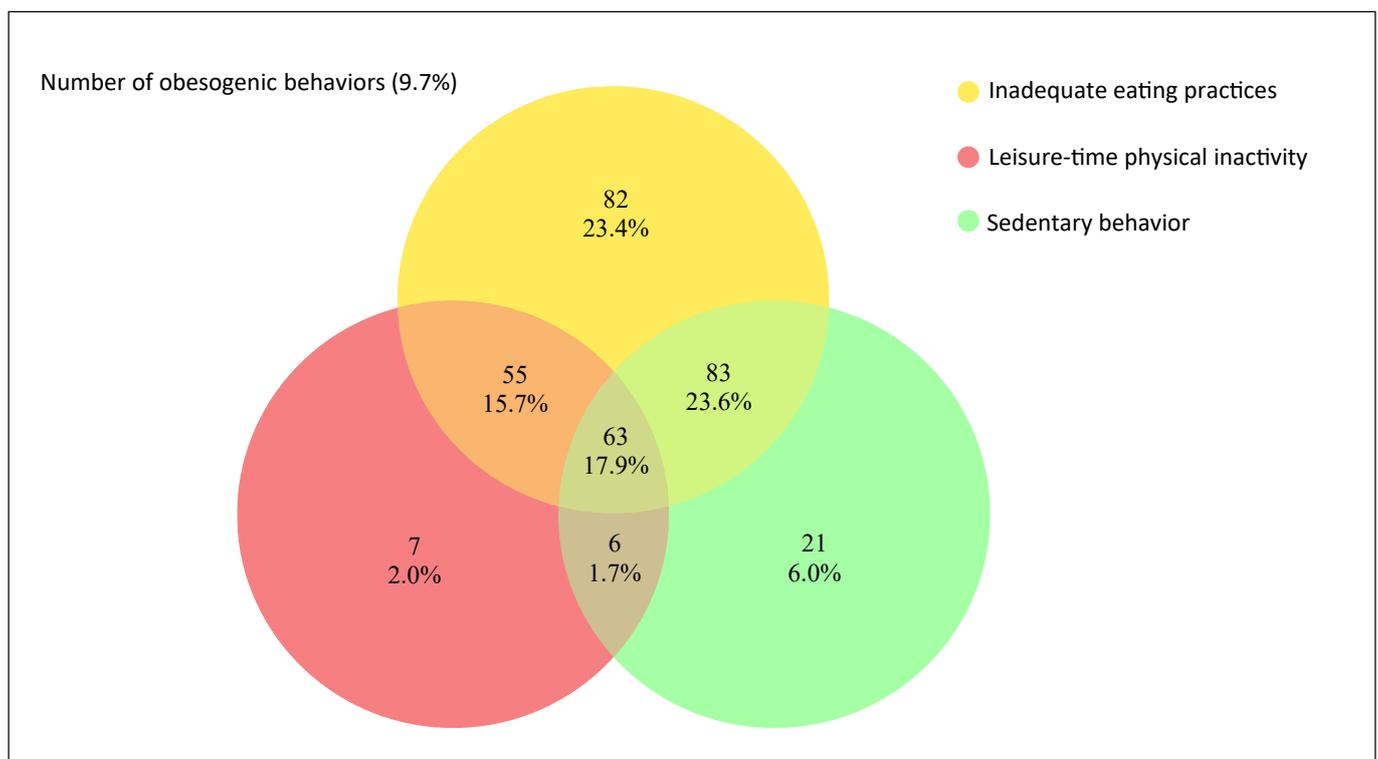


Figure 1. Co-occurrence of obesogenic behaviors (inadequate eating practices, leisure-time physical inactivity, and sedentary behavior) in university students entering the Universidade Federal de Ouro Preto in 2019. Ouro Preto, Minas Gerais, 2019 (n = 351).

with the co-occurrence of two or more obesogenic behaviors. With the transition from high school to higher education, university students face many changes, such as lack of time due to studies, overlapping activities, and new responsibilities, which may interfere with adopting healthy eating practices.<sup>30</sup> In addition, many factors, such as socioeconomic status, lack of ability to make healthy food choices, difficulty cooking, lack of healthy food in university

cafeterias, and “environmental barriers,” such as opening hours of nearby food stores, influence the availability of food, and negatively affect students’ eating behaviors.<sup>30,31</sup>

These factors may favor new eating habits, reflected in unhealthy eating practices and health-related problems, including being overweight.<sup>32-34</sup> Thus, health promotion strategies, including promoting healthy eating in the university environment, are vital, as numerous health behaviors are developed and established during this period<sup>30</sup> and tend to continue into adulthood, increasing the risk of developing chronic diseases in subsequent years.<sup>15</sup>

Exposure to health-risk behaviors has been described in studies with young populations.<sup>9</sup> Studies that evaluated the aggregation of inadequate eating practices and SB showed that these factors share contextual determinants and influence each other.<sup>35</sup> In the present study, we found that the most prevalent combination of risk behaviors among university students was the coexistence of inadequate eating practices and SB. In contrast, in a study of adults, SB, including the habit of watching television, using a computer, reading books, or magazines, remained associated with the consumption of healthy and unhealthy foods.<sup>36</sup> However, comparisons between the risk factors analyzed should be interpreted with caution, given the various methods used to assess food intake. It is noteworthy that the instrument used in the present study included other dimensions of adequate and healthy eating and food intake.

Scientific evidence shows that SB reduces energy expenditure and favors inadequate food consumption, including increased intake of foods rich in fat and sugars and decreased consumption of healthy foods such as fruits and vegetables.<sup>35,36</sup> Moreover, besides being risk factors for becoming overweight, this association between high screen time and inadequate eating habits may increase susceptibility to other health-risk behaviors,<sup>35</sup> resulting directly in series of unfavorable health outcomes.<sup>37</sup>

The simultaneous occurrence of the three risk behaviors assessed, characterized by inadequate eating practices, leisure-time physical inactivity, and SB, was prevalent in 17.9% of university students. Few studies have investigated the clustering of health risk behaviors among university students.<sup>13</sup> In a study conducted with Brazilian university students, a high prevalence was observed for the simultaneous occurrence of the four primary behavioral risk factors for NCDs: physical inactivity, inadequate fruit and vegetable consumption, excessive alcohol consumption, and smoking.<sup>38</sup> The study did not include SB in its analyses since this risk factor has been less studied than other risk behaviors already established in the literature, such as food intake and physical activity. It is worth noting the importance of investigating the aggregation of traditional and emerging risk behaviors among young people, especially university students, to provide information on which to base future actions.<sup>13</sup>

**Table 2.** Odds ratio (OR) and 95% confidence interval (95% CI) for one or more obesogenic behaviors; multivariate model of sociodemographic characteristics and health conditions associated with the co-occurrence of obesogenic behaviors in university students entering the Universidade Federal de Ouro Preto in 2019. Ouro Preto, Minas Gerais, 2019 (n = 351)

| <b>Model one: No obesogenic behavior versus one obesogenic behavior</b>      |      |              |         |
|--|------|--------------|---------|
| Variables  | OR   | 95% CI       | P value |
| <b>Age (n = 348)</b>   |      |              |         |
| > 20 years   | 1    |              | 0.003   |
| ≤ 20 years   | 3.68 | (1.58–8.59)  |         |
| <b>Skin color (n = 350)</b>  |      |              |         |
| White  | 1    |              | 0.016   |
| Non-white (yellow, brown, mulatto, or black)                                 | 3.09 | (1.23–7.74)  |         |
| <b>Model two: No obesogenic behavior versus two obesogenic behaviors</b>     |      |              |         |
| Variables  | OR   | 95% CI       | P value |
| <b>Age (n = 348)</b>   |      |              |         |
| > 20 years   | 1    |              | 0.014   |
| ≤ 20 years   | 2.77 | (1.23–6.26)  |         |
| <b>Skin color (n = 350)</b>  |      |              |         |
| White  | 1    |              | 0.001   |
| Non-white (yellow, brown, mulatto, or black)                                 | 4.61 | (1.88–11.31) |         |
| <b>Self-rated health</b>   |      |              |         |
| Good (very good and good)  | 1    |              | 0.033   |
| Bad (regular, bad, and very bad)   | 2.70 | (1.09–6.71)  |         |
| <b>Model three: No obesogenic behavior versus three obesogenic behaviors</b> |      |              |         |
| Variables  | OR   | 95% CI       | P value |
| <b>Age (n = 348)</b>   |      |              |         |
| > 20 years   | 1    |              | 0.018   |
| ≤ 20 years   | 3.34 | (1.23–9.05)  |         |
| <b>Skin color (n = 350)</b>  |      |              |         |
| White  | 1    |              | 0.027   |
| Non-white (yellow, brown, mulatto, or black)                                 | 3.31 | (1.15–9.58)  |         |
| <b>Depression symptoms</b>   |      |              |         |
| No   | 1    |              | 0.001   |
| Yes  | 6.15 | (2.10–18.05) |         |

OR = odds ratio; CI = confidence interval.

In this study, the co-occurrence of obesogenic behaviors was associated with students' skin color, differing from the findings of Cureau, Duarte, and Teixeira,<sup>38</sup> who found no association between the simultaneous presence of three or more behavioral risk factors and skin color of university students. Studies that have evaluated this association are scarce, making comparisons difficult. However, there is evidence showing that ethnic and racial minorities, the black community in particular, have a high prevalence of obesity and obesogenic behavior. Social inequalities make access to health difficult for groups that live in the same environment, such as universities. In this context, studies highlight the urgent need for broad-based, affirmative actions and policies to overcome racial disparities.<sup>39,40</sup>

In this study, we also observed that university students who self-rated their health as bad had a higher chance of one, two, or three obesogenic behaviors than those who self-rated their health as good. Studies show that individuals who perceive their health as bad tend to present more health risk behaviors,<sup>41</sup> such as inadequate intake of fruits and vegetables, physical inactivity, and SB. These behaviors are determinants of NCDs and are related to the negative subjective assessment of health.<sup>42</sup> Thus, these findings highlight the importance of considering how health is perceived by university students since perceptions of health can influence the adoption of healthy lifestyle behaviors.<sup>43</sup>

The presence of depressive symptoms was associated with the co-occurrence of obesogenic behaviors among university students, corroborating the findings of Champion et al.,<sup>13</sup> who evaluated 18-year-old Australian youth and observed a significant association between the clustering of multiple health-risk behaviors and mental health outcomes such as anxiety and depression. One hypothesis to justify this association is that individuals may engage in unhealthy behaviors to help cope with mental health problems.<sup>44</sup> In addition, stress and mental health disorders may interfere with a person's choice to adopt healthy lifestyle behaviors such as physical activity, while also exposing themselves to health-risk behaviors.<sup>45</sup>

There was a greater chance of exposure to multiple obesogenic behaviors among university students aged 20 years or younger. Evidence shows that the prevalence of simultaneous exposure to health risk behaviors increases with age,<sup>9,46</sup> since young people acquire greater autonomy and economic independence with advancing age.<sup>9</sup> However, this association has not been well established in the literature. In a systematic review of the co-occurrence of multiple risk behaviors, older age groups were considered risk factors for aggregating multiple risk behaviors.<sup>12</sup>

Although the findings of this study are consistent with those reported in the literature, some limitations should be considered when interpreting the results. Students from a single university were included, limiting comparisons with students from other

higher education institutions. Another limitation of the study is the methodological design, which does not establish a cause-effect relationship between the variables and temporal relationships on the associations found. In addition, as the students were evaluated in their initial semester at the university, their recent entry into academic life may not have set their lifestyles.

It is important to highlight that this study was based on self-reported behaviors, which may have generated information bias, as young people tend to overestimate or underestimate their exposure to health risk behaviors. Despite these limitations, the findings obtained add essential evidence regarding the prevalence and factors associated with the co-occurrence of obesogenic behaviors among university students.

## CONCLUSION

The findings from this study showed that a high proportion of university students with simultaneous obesogenic behaviors, especially among those who self-reported colored skin, rated their health as bad, and reported depressive symptoms. These findings contribute to a better understanding of the associations between various obesogenic behaviors, highlighting the need for interventions directed at university students. In addition, these results highlight the importance of health promotion in the university environment, with actions aimed at a healthy lifestyle. Public policies that target risk behaviors in groups and stimulate a healthy food environment and physical activity in universities are essential for reducing the risk of major chronic diseases related to excess weight.

## REFERENCES

1. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. *Metabolism*. 2019;92:6-10. PMID: 30253139; <https://doi.org/10.1016/j.metabol.2018.09.005>.
2. Maia EG, Mendes LL, Pimenta AM, Levy RB, Claro RM. Cluster of risk and protective factors for obesity among Brazilian adolescents. *Int J Public Health*. 2018;63(4):481-90. PMID: 29143071; <https://doi.org/10.1007/s00038-017-1053-7>.
3. Nimptsch K, Konigorski S, Pischon T. Diagnosis of obesity and use of obesity biomarkers in science and clinical medicine. *Metabolism*. 2019;92:61-70. PMID: 30586573; <https://doi.org/10.1016/j.metabol.2018.12.006>.
4. Di Cesare M, Soric M, Bovet P, et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. *BMC Med*. 2019;17(1): 212. PMID: 31760948; <https://doi.org/10.1186/s12916-019-1449-8>.
5. Streb AR, Duca GFD, Silva RPD, Benedet J, Malta DC. Simultaneidade de comportamentos de risco para a obesidade em adultos das capitais do Brasil [Simultaneity of risk behaviors for obesity in adults in the capitals of Brazil]. *Cien Saude Colet*. 2020;25(8):2999-3007. PMID: 32785536; <https://doi.org/10.1590/1413-81232020258.27752018>.

6. Malta DC, Silva AG, Cardoso LSM, et al. Noncommunicable diseases in the Journal *Ciência & Saúde Coletiva*: a bibliometric study. *Cien Saude Colet*. 2020;25(12):4757-69. PMID: 33295499; <https://doi.org/10.1590/1413-812320202512.16882020>.
7. Hardy LL, Grunseit A, Khambalia A, et al. Co-occurrence of obesogenic risk factors among adolescents. *J Adolesc Health*. 2012;51(3):265-71. PMID: 22921137; <https://doi.org/10.1016/j.jadohealth.2011.12.017>.
8. Uddin R, Lee EY, Khan SR, Tremblay MS, Khan A. Clustering of lifestyle risk factors for non-communicable diseases in 304,779 adolescents from 89 countries: A global perspective. *Prev Med*. 2020;131:105955. PMID: 31862205; <https://doi.org/10.1016/j.ypmed.2019.105955>.
9. da Silva Brito AL, Hardman CM, de Barros MV. Prevalência e fatores associados à simultaneidade de comportamentos de risco à Saúde em adolescente [Prevalence and factors associated with the co-occurrence of health risk behaviors in adolescents]. *Rev Paul Pediatr*. 2015;33(4):423-30. PMID: 26298656; <https://doi.org/10.1016/j.rpped.2015.02.002>.
10. Bista B, Dhungana RR, Chalise B, Pandey AR. Prevalence and determinants of non-communicable diseases risk factors among reproductive aged women of Nepal: Results from Nepal Demographic Health Survey 2016. *PLoS One*. 2020;15(3):0218840. PMID: 32176883; <https://doi.org/10.1371/journal.pone.0218840>.
11. de Winter AF, Visser L, Verhulst FC, Vollebergh WAM, Reijneveld S. Longitudinal patterns and predictors of multiple health risk behaviors among adolescents: The TRAILS study. *Prev Med*. 2016;84:76-82. PMID: 26656404; <https://doi.org/10.1016/j.ypmed.2015.11.028>.
12. Meader N, King K, Moe-Byrne T, et al. A systematic review on the clustering and co-occurrence of multiple risk behaviours. *BMC Public Health*. 2016;16:657. PMID: 27473458; <https://doi.org/10.1186/s12889-016-3373-6>.
13. Champion KE, Mather M, Spring B, et al. Clustering of Multiple Risk Behaviors Among a Sample of 18-Year-Old Australians and Associations With Mental Health Outcomes: A Latent Class Analysis. *Front Public Health*. 2018;6:135. PMID: 29868543; <https://doi.org/10.3389/fpubh.2018.00135>.
14. Laska MN, Pasch KE, Lust K, Story M, Ehlinger ED. Latent class analysis of lifestyle characteristics and health risk behaviors among college youth. *Prev Sci*. 2009;10(4):376-86. PMID: 19499339; <https://doi.org/10.1007/s11121-009-0140-2>.
15. Olatona FA, Onabanjo OO, Ugbaja RN, Nnoaham KE, Adelekan DA. Dietary habits and metabolic risk factors for non-communicable diseases in a university undergraduate population. *J Health Popul Nutr*. 2018;37(1):21. PMID: 30115131; <https://doi.org/10.1186/s41043-018-0152-2>.
16. Busse H, Buck C, Stock C, et al. Engagement in Health Risk Behaviours before and during the COVID-19 Pandemic in German University Students: Results of a Cross-Sectional Study. *Int J Environ Res Public Health*. 2021;18(4):1410. PMID: 33546344; <https://doi.org/10.3390/ijerph18041410>.
17. World Health Organization. Global status report on noncommunicable diseases 2010. Geneva: World Health Organization; 2011. Available from: <https://apps.who.int/iris/handle/10665/44579>. Accessed in 2022 (May 16).
18. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Guia alimentar para a população brasileira/Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Básica. - 2.ed. 1. reimpr. - Brasília: Ministério da Saúde, 2014. Available from: [https://bvsm.sau.gov.br/bvs/publicacoes/guia\\_alimentar\\_populacao\\_brasileira\\_2ed.pdf](https://bvsm.sau.gov.br/bvs/publicacoes/guia_alimentar_populacao_brasileira_2ed.pdf). Accessed in 2022 (May 04).
19. Gabe KT, Jaime PC. Development and testing of a scale to evaluate diet according to the recommendations of the Dietary Guidelines for the Brazilian Population. *Public Health Nutr*. 2019;22(5):785-96. PMID: 30744711; <https://doi.org/10.1017/S1368980018004123>.
20. Brasil. Ministério da Saúde. Secretaria de Atenção Primária à Saúde. Departamento de Atenção Básica. Teste "Como está a sua alimentação?". Brasília: Ministério da Saúde; 2018. Available from: [http://189.28.128.100/dab/docs/portaldab/publicacoes/guiadebolso\\_folder.pdf](http://189.28.128.100/dab/docs/portaldab/publicacoes/guiadebolso_folder.pdf). Accessed in 2022 (May 04).
21. Gabe KT, Jaime PC. Dietary practices in relation to the Dietary guidelines for the Brazilian population: associated factors among Brazilian adults, 2018. *Epidemiol Serv Saude*. 2020;29(1):e2019045. PMID: 32215534; <https://doi.org/10.5123/S1679-49742020000100019>.
22. BRASIL. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Análise em Saúde e Vigilância de Doenças Não Transmissíveis. Vigitel Brasil 2019: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados brasileiros e no Distrito Federal em 2019 [recurso eletrônico]/Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Análise em Saúde e Vigilância de Doenças não Transmissíveis. Brasília: Ministério da Saúde; 2020. Available from: [https://bvsm.sau.gov.br/bvs/publicacoes/vigitel\\_brasil\\_2019\\_vigilancia\\_fatores\\_risco.pdf](https://bvsm.sau.gov.br/bvs/publicacoes/vigitel_brasil_2019_vigilancia_fatores_risco.pdf). Accessed in 2022 (Mar 10).
23. Silva RMA, Andrade ACS, Caiaffa WT, Medeiros DSD, Bezerra VM. National Adolescent School-based Health Survey - PeNSE 2015: Sedentary behavior and its correlates. *PLoS One*. 2020;15(1):e0228373. PMID: 31999792; <https://doi.org/10.1371/journal.pone.0228373>.
24. World Health Organization. Obesity: preventing and managing the global epidemic: report of a WHO consultation. (WHO Technical Report Series n.894). Geneva, Switzerland: World Health Organization, 2000. Available from: <https://apps.who.int/iris/handle/10665/42330>. Accessed in 2022 (May 04).
25. de Onis M, Onyango AW, Borghi E, et al. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ*. 2007;85(9):660-7. PMID: 18026621; <https://doi.org/10.2471/blt.07.043497>.
26. Barbosa BCRB, Guimarães NS, Paula W, Meireles AL. Práticas alimentares de estudantes universitários da área da saúde, de acordo com as recomendações do guia alimentar para a população brasileira. *Demetra*. 2020;15:e45855. <https://doi.org/10.12957/demetra.2020.45855>.

27. Vignola RC, Tucci AM. Adaptation and validation of the depression, anxiety and stress scale (DASS) to Brazilian Portuguese. *J Affect Disord.* 2014;155:104-9. PMID: 24238871; <https://doi.org/10.1016/j.jad.2013.10.031>.
28. Heberle H, Meirelles GV, da Silva FR, Telles GP, Minghim R. InteractiVenn: a web-based tool for the analysis of sets through Venn diagrams. *BMC Bioinformatics.* 2015;16(1):169. PMID: 25994840; <https://doi.org/10.1186/s12859-015-0611-3>.
29. Hulsen T, de Vlieg J, Alkema W. BioVenn - a web application for the comparison and visualization of biological lists using area-proportional Venn diagrams. *BMC Genomics.* 2008;9:488. PMID: 18925949; <https://doi.org/10.1186/1471-2164-9-488>.
30. Hilger J, Loerbroks A, Diehl K. Eating behaviour of university students in Germany: Dietary intake, barriers to healthy eating and changes in eating behaviour since the time of matriculation. *Appetite.* 2017;109:100-7. PMID: 27864073; <https://doi.org/10.1016/j.appet.2016.11.016>.
31. Abdelhafez AI, Akhter F, Alsultan AA, Jalal SM, Ali A. Dietary Practices and Barriers to Adherence to Healthy Eating among King Faisal University Students. *Int J Environ Res Public Health.* 2020;17(23):8945. PMID: 33271893; <https://doi.org/10.3390/ijerph17238945>.
32. Soriano-Ayala E, Amutio A, Franco C, Mañas I. Promoting a healthy lifestyle through mindfulness in university students: a randomized controlled trial. *Nutrients.* 2020;12(8):2450. PMID: 32824061; <https://doi.org/10.3390/nu12082450>.
33. Souza RK, Backes V. Autopercepção do consumo alimentar e adesão aos Dez Passos para Alimentação Saudável entre universitários de Porto Alegre, Brasil [Self-perception of food consumption and observance of the Ten Steps to Healthy Eating among university students in Porto Alegre, Brazil]. *Cienc Saude Colet.* 2020;25(11):4463-72. PMID: 33175054; <https://doi.org/10.1590/1413-812320202511.35582018>.
34. Syed NK, Syed MH, Meraya AM, et al. The association of dietary behaviors and practices with overweight and obesity parameters among Saudi university students. *PLoS One.* 2020;15(9):e0238458. PMID: 32911507; <https://doi.org/10.1371/journal.pone.0238458>.
35. Ferreira NL, Claro RM, Mingoti SA, Lopes ACS. Coexistence of risk behaviors for being overweight among Brazilian adolescents. *Prev Med.* 2017;100:135-42. PMID: 28412185; <https://doi.org/10.1016/j.ypmed.2017.04.018>.
36. Jezewska-Zychowicz M, Gębski J, Guzek D, et al. The associations between dietary patterns and sedentary behaviors in Polish adults (LifeStyle study). *Nutrients.* 2018;10(8):1004. PMID: 30071656; <https://doi.org/10.3390/nu10081004>.
37. Rocha BMC, Goldbaum M, César CLG, Stopa SR. Sedentary behavior in the city of São Paulo, Brazil: ISA-Capital 2015. *Rev Bras Epidemiol.* 2019;22:e190050. PMID: 31460665; <https://doi.org/10.1590/1980-549720190050>.
38. Cureau FV, Duarte PM, Teixeira FS. Simultaneidade de comportamentos de risco para doenças crônicas não transmissíveis em universitários de baixa renda de uma cidade do Sul do Brasil. *Cad Saude Colet.* 2019;27(3):316-24. <https://doi.org/10.1590/1414-462X201900030178>.
39. da Silva TPR, Matozinhos FP, Gratão LHA, et al. The coexistence of obesogenic behaviors among Brazilian adolescents and their associated factors. *BMC Public Health.* 2022;22(1):1290. PMID: 35788201; <https://doi.org/10.1186/s12889-022-13708-6>.
40. Fleary SA, Freund KM. Social Disparities in Obesogenic Behaviors in Adolescents. *J Racial Ethn Health Disparities.* 2018;5(1):24-33. PMID: 28130748. <https://doi.org/10.1007/s40615-017-0339-z>.
41. Barreto SM, Figueiredo RC. Chronic diseases, self-perceived health status and health risk behaviors: gender differences. *Rev Saude Publica.* 2009;43 Suppl 2:38-47. PMID: 19936497; <https://doi.org/10.1590/S0034-89102009000900006>.
42. Francisco PMSB, Assumpção D, Borim FSA, Senicato C, Malta DC. Prevalence and co-occurrence of modifiable risk factors in adults and older people. *Rev Saude Publica.* 2019;53:86. PMID: 31644769; <https://doi.org/10.11606/s1518-8787.2019053001142>.
43. Barros MB, Zanchetta LM, Moura EC, Malta DC. Self-rated health and associated factors, Brazil, 2006. *Rev Saude Publica.* 2009;43 Suppl 2:27-37. PMID: 19936496; <https://doi.org/10.1590/S0034-89102009000900005>.
44. Jao NC, Robinson LD, Kelly PJ, Ciecierski CC, Hitsman B. Unhealthy behavior clustering and mental health status in United States college students. *J Am Coll Health.* 2019;67(8):790-800. PMID: 30485154; <https://doi.org/10.1080/07448481.2018.1515744>.
45. Michels N. Poor Mental Health Is Related to Excess Weight via Lifestyle: A Cross-Sectional Gender- and Age-Dependent Mediation Analysis. *Nutrients.* 2021;13(2):406. PMID: 33525320; <https://doi.org/10.3390/nu13020406>.
46. Sousa TF, Loch MR, Lima AJO, Franco DC, Barbosa AR. Coocorrência de fatores de risco à saúde em universitários de uma instituição de ensino superior brasileira [Co-occurrence of risk factors to health among university students of a Brazilian tertiary education institution]. *Cienc Saude Colet.* 2021;26(2):729-38. PMID: 33605347; <https://doi.org/10.1590/1413-81232021262.07062019>.

**Author's contributions:** Barbosa BCRB: conceptualization (equal), data curation (equal), formal analysis (equal), investigation (equal), methodology (equal), software (equal), validation (equal), visualization (equal), writing-original draft (equal) and writing-review and editing (equal); Parajara MC: data curation (equal), formal analysis (equal), investigation (equal), methodology (equal), software (equal) and writing-review and editing (equal); Paula W: data curation (equal), project administration (equal) and writing-review and editing (equal); Machado EL: validation (equal), visualization (equal) and writing-review and editing (equal); and Meireles AL: conceptualization (equal), investigation (equal), methodology (equal), project administration (equal), supervision (equal), validation (equal) critical review and writing-review and editing (equal). All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work

**Sources of funding:** The authors are thankful to the Universidade Federal de Ouro Preto for making contact with research participants possible, the Grupo de Pesquisa e Ensino em Nutrição e Saúde Coletiva (GPENSC), the Projeto sobre Ansiedade e Depressão em Universitários (PADu) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (financing code 001). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of this article

**Conflict of interest:** All authors declare that they have no conflict of interest

**Date of first submission:** May 16, 2022

**Last received:** August 30, 2022

**Accepted:** October 10, 2022

**Address for correspondence:**

Adriana Lúcia Meireles  
Escola de Nutrição, Universidade Federal de Ouro Preto (UFOP), Campus Morro do Cruzeiro  
R. Dois, 607  
Morro do Cruzeiro — Ouro Preto (MG) — Brasil  
CEP 35400-000  
Tel. (+55 31) 3559-1838  
E-mail: [adriana.meireles@ufop.edu.br](mailto:adriana.meireles@ufop.edu.br)

**Editor responsible for the evaluation process:**

Paulo Manuel Pêgo-Fernandes, MD, PhD.

