MULTIVARIATE ASSOCIATION OF MENTAL HEALTH WITH HABITUAL, MOVEMENT, AND SEDENTARY BEHAVIORS IN AN ACADEMIC COMMUNITY

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ABSTRACT

This study aimed to assess mental health (MS) by investigating feelings of isolation, sadness-depression, and anxiety-nervousness, and associating them with sociodemographic and behavioral factors, health status, and body mass index in a university community. This is an observational and cross-sectional study, with a sample composed of 1,655 volunteers, of both sexes, aged between 17 and 72 years, belonging to different segments of the academic community of a public institution in the interior of Brazil. An adapted version of the "ConVid: Behavior Survey" questionnaires and the short

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version of the "*International Physical Activity Questionnaire* (IPAQ)" were used, adopting a significance level of α = 5% for statistical analyses. The grouping of feelings was performed using the *Two Step Cluster* method, and the resulting classification was analyzed by multinomial regression and Multiple Correspondence Analysis. The *cluster* model generated seven adjusted classes and, based on this, three mental health categories were defined: "worst MS", "moderate MS" and "best MS". The regression showed that age up to 39 years, female gender, reduction or maintenance of income during the pandemic, receipt of Emergency Aid, diagnosis of chronic non-communicable diseases, experience of severe cases or deaths of family members/friends, moderate or intense difficulties in the work or study routine, poor sleep quality, not reaching the recommendations for moderate and vigorous physical activity, daily screen use for ≥ 4 hours and body mass index classified as eutrophic were associated with higher odds of worse MS classification. It is concluded, based on the clusters and multivariate analyses, that changes in behaviors, lifestyle, and socioeconomic context caused by social isolation resulting from COVID-19 significantly increased the chances of classifying the university population evaluated as the worst MS.

Keywords: Mental Health. Physical Activity. Screen Time. Sleep. COVID-19.

INTRODUCTION

Mental Health (MH), according to the World Health Organization (WHO, 2022), is defined as a state of well-being in which the individual recognizes their capabilities, is able to deal with life's stressors, work productively, and contribute to their community. It is, therefore, an expanded concept, which goes beyond the simple absence of mental illnesses and involves the ability to adapt emotionally, psychological balance, self-realization, and healthy social relationships (WHO, 2022). In this context, it is necessary to evaluate the symptoms and feelings that, even when they do not characterize a diagnosable disorder, indicate significant psychological suffering.

Among the main feelings associated with this suffering, loneliness, sadness, depression, anxiety and nervousness stand out, all of which are recognized by the literature as relevant predictors for the emergence of mental disorders when they persist frequently or intensely (WHO, 2001; APA, 2014).

The COVID-19 pandemic, which began in December 2019, imposed on global society a series of abrupt transformations that had intense repercussions on the physical, social, emotional, and behavioral spheres of individuals (Malta et al., 2020b; Howe et al., 2021; Paixão et al., 2024). Among the various impacts, MS emerged as one of the most affected dimensions, evidencing significant changes in subjective well-being, increased anxiety, depression, nervousness, and feelings of loneliness (Malta et al., 2020a; WHO, 2022).

Studies show that the pandemic contributed to the intensification of these feelings, generating psychological suffering even in the absence of a formal diagnosis of mental disorders (Di Fazio et al., 2022). The World Mental Health Report estimates that there was a global increase of 28% in depressive disorders and 26% in anxiety disorders by 2022, with the highest rates observed in regions most affected by the virus, such as Brazil (WHO, 2022). This scenario reinforces the need to understand the regional and population impact of the pandemic on mental well-being, especially in vulnerable groups, such as the university population.

With the measures to contain the virus, such as social isolation, prolonged quarantines, and the closure of collective spaces, there have been profound changes in the routine and lifestyle of the population (Guilherme et al., 2023; Bedim et al., 2024a;). The interruption of school, work, social, and leisure activities negatively affected the practice of physical activity, increased sedentary behavior, and changed habits such as sleep (Werneck et al., 2020c), the use of screens, and interpersonal interaction (Werneck et al., 2021a; Werneck et al., 2021c). Although these restrictions have been essential for

controlling viral spread (Silva et al., 2021a), their side effects on mental health still need to be widely investigated, especially among specific populations such as university students.

The literature points out that healthy movement behaviors, such as regular physical activity, are associated with better mental health indices, acting as a protective factor against depressive and anxious symptoms, in addition to favoring emotional and cognitive well-being (WHO, 2020; Bedim et al., 2024b). On the other hand, the grouping of behaviors considered "unhealthy" — such as sedentary lifestyle, poor sleep quality, increased screen time, and social habits such as alcohol and tobacco consumption — has been correlated with poorer quality of life and higher levels of psychological distress, such as sadness, depression, anxiety, and nervousness (Stanton et al., 2020; Werneck et al., 2021b; Szwarcwald et al., 2021b; Bedim et al., 2024b).

Considering the complexity of the effects of the pandemic on people's daily lives, especially on behaviors that influence mental health, it is relevant to understand how these factors interact with each other. The university population, due to its academic nature, age group and emotional demands, represents a group particularly vulnerable to these impacts. Assessing feelings of loneliness, sadness, depression, anxiety and nervousness allows us to draw a broader picture of psychological suffering in this population.

In view of this, this study aims to evaluate aspects of mental health in a multivariate and grouped way, through the investigation of feelings of isolation, sadness, depression, anxiety, and nervousness, and to associate these indicators with sociodemographic factors, health status, habitual, movement, and sedentary behaviors, social habits, sleep quality, and body mass index of the university community during the COVID-19 pandemic period. This approach, by considering mental health in its complexity and interdependence with multiple variables, may represent a new evaluative perspective, more sensitive to the nuances of psychological distress and the contextual factors that influence it.

METHODOLOGY

This study is observational, cross-sectional in nature and epidemiological. The approach used is based on other previously published studies, such as the study by Guilherme et al. (2023), Bedim et al. (2024a) and Bedim et al. (2024b). All ethical precautions were taken in accordance with resolution 466/2012, to ensure the integrity of the participants, upon approval by the Ethics Committee for Research with Human Beings of the Federal University of Viçosa (CEP-UFV), CAAE: 47115021.9.0000.5153 and registration opinion: 4.932.423, thus complying with the Brazilian legislation with research with human beings.

PARTICIPANTS

The sample was composed of participants of both sexes, between 17 and 72 years old, belonging to the three segments of the academic community of the Federal University of Viçosa (UFV), which has three campuses in Minas Gerais, Brazil. The selection was proportional to the size of the population of each campus, with a design effect adjustment of 2.0 to ensure representativeness. In 2021, UFV had 20,084 members, including students, professors, and technical-administrative staff (UFV, 2022).

Based on this information, the sample size was calculated using the *StatCalc program* of the *EpiInfoTM software*, version 7.2.5.0 (Georgia, United States). The calculation considered a confidence level of 95%, a prevalence of 50% for the variables analyzed, and a maximum allowable error of 5%. The result indicated a minimum sample size of 1284 individuals.

PROCEDURES

With the approval of the CEP-UFV, the participants were contacted by institutional email and the survey was released in two moments between September and October 2021, with the questionnaire available for 30 days. Data collection was carried out electronically, via Google Forms (*Google Forms - Google LLC,® Mountain View, California, USA*) due to the restrictions of the COVID-19 pandemic and the adoption of remote work.

INSTRUMENTS

To assess socioeconomic, behavioral, lifestyle habits, sedentary lifestyle, and sleep quality aspects during the COVID-19 pandemic, an adapted version of the questionnaire "ConVid: Behavior Research", developed by the Oswaldo Cruz Foundation (FIOCRUZ) (Szwarcwald et al., 2021a), was used. The original instrument, consisting of 85 questions, was applied to more than 43 thousand participants and focused on investigating biopsychosocial behaviors in the pandemic context (Malta *et al.,* 2020a; Malta *et al.,* 2020b; Werneck *et al.,* 2020a; Werneck *et al.,* 2020b; Werneck *et al.,* 2020c; Werneck *et al.,* 2021a; Werneck *et al.,* 2021b; Szwarcwald *et al.,* 2021b; Lima *et al*., 2021).

The final version applied had 46 questions, organized into eight thematic sections, namely: participant profile; how the pandemic affected/changed your life; health in general and problems faced during the pandemic; difficulties in routine; mood; changes in habits; level and types of physical activity; screen time; and the body mass ratio.

In addition to ConVid, the short version of the *International Physical Activity Questionnaire* (IPAQ) was also used, an instrument validated for the Brazilian population by

Matsudo *et al.* (2001), following their classification parameters into "Sedentary", "Irregularly Active A and B", "Active" and "Very Active", duly dichotomized into "Irregularly Active", that is, those who did not reach the physical activity (PA) recommendations and "Active" those who reached the PA recommendations.

The body mass ratio was based on the Body Mass Index (BMI) according to the WHO classification (WHO, 1995): "underweight" (<18.5), "normal weight" (18.5 – 24.9), "overweight" (25.0 – 29.9) and "obesity" (>30.0).

As markers of MS, questions were used referring to the feelings of sadness-depression; anxiety-nervousness and isolation (loneliness), whose answers could be "Never", "Few Times", "Many Times" or "Always", dichotomized into "Few Times/Never (NPV)" and "Many Times/Always (MVS)".

STATISTICAL ANALYSIS

The data collected in the electronic survey questionnaire were downloaded in the *Microsoft Excel spreadsheet (Microsoft®, Albuquerque, New Mexico, USA), Professional Plus 2016 version*, for verification of the tabulated information carried out by two researchers, independently. Soon after, the data spreadsheet was analyzed using *the Statistical Package for the Social Sciences (SPSS) for Windows*, version 21.0 (*IBM Corporation®, New York, United States). The level of rejection of the nullity hypothesis adopted will be* α = 5%.

Multiple Correspondence Analysis (MCA)

Initially, the MCA was used to verify the dispersion and approximation in a preliminary exploratory way of the categories for each variable related to MS, demonstrating through graphic representation the correspondence between the categories and, thus, taking as a basis two dimensions (1 and 2) of the variables "feeling of isolation (loneliness)", "sadness and depression", and, finally, "anxiety and nervousness". The distribution of the categories and the internal consistency coefficient of each dimension were analyzed by the value of Inertia and Cronbach's Alpha (α), respectively. Inertia shows how close and corresponding the categories are, while Cronbach's α internal consistency, classifying it according to Landis and Koch (1977) as: 0 to 0.21 – small; 0.21 to 0.40 – reasonable; 0.41 to 0.60 – moderate; 0.61 to 0.80 – substantial; 0.81 to 1.0 – almost perfect. The correspondence between the dichotomous variables ("isolation, sadness/depression, anxiety/nervousness, MVS and PVN") was verified, involving 6 response categories in the diagram.

Two Step Cluster (TSC)

For categorization and grouping of information related to mental health, CST analysis was used. The rules for the selection of the number of groups were based on the number of clusters that resulted in the best combination of low Bayesian Schwarz Criterion (BIC), greater number of categories with importance values close to 1, measure of cohesion and separation of classes, being considered good values greater than 0.5, and finally, proportion between the highest and lowest prevalence of the classes generated. The clusters were tested using each of the manifest variables as a reference, and the values of the responses were separately ordered in ascending order. Thus, after evaluating the quality criteria, the model with the best fit was selected.

Multinomial Regression

Multinomial regression analyses were used to verify the association and independently evaluate the assessment measures of the set of three variables related to MS ("worst", "moderate", and "best") with the other explanatory variables (sociodemographic factors, health status, COVID-19, routine, movement, and sedentary behaviors, sleep, social habits, and BMI). The values of β, crude odds *ratio* (OR), 95% confidence interval (95%CI) and p-values between "worst *versus* best MS" and "moderate *versus* best MS" were presented and interpreted.

RESULTS

Sampling characteristics

Among the 1,655 participants in the study, 78.1% (n = 1,293) belonged to the student body and 21.9% (n = 362) to the civil servants. Regarding the age group, 82.5% (n = 1,365) were up to 39 years old, while 17.5% (n = 290) were 40 years old or older. Regarding gender, 57.4% (n = 950) identified themselves as female and 42.0% (n = 695) as male. In ethnic-racial terms, 59.7% (n = 988) of the participants declared themselves white, and 40.3% (n = 667) identified themselves as black, brown, yellow, or indigenous. With regard to income, 52.9% (n = 876) reported a reduction or total loss of income during the pandemic, 42.2% (n = 699) reported having maintained the same amount of income as in the pre-pandemic period, and 3.5% (n = 58) reported an increase. Regarding the receipt of emergency benefits from the government, 57.4% (n = 950) did not receive it, while 41.1% (n = 680) reported having received it.

Multiple Correspondence Analysis

The MCA showed a moderate correlation graphically, especially between the variables "sadness and depression MVS" and "anxiety and nervousness MVS", that is, the volunteer who showed himself to be often or always sad, depressed, anxious and nervous. Dimension 1 explained 62.8% of the distribution of the variables, inertia value; with an internal consistency coefficient, Cronbach's α, of 0.704, showing a substantial internal reliability between the MVS responses to these feelings (Landis; Koch, 1977) (Figure 1). Dimension 2 presented an inertia value of 23.2% and Cronbach's α, of -0.652, showing reliability or non-existent internal consistency, also substantially (Maroco; Garcia-Marques, 2006).

Figure 1 – Diagram of the Multiple Correspondence Analysis between the categories of dichotomous responses of the variables "isolation", "sadness and depression" and "anxiety and nervousness".

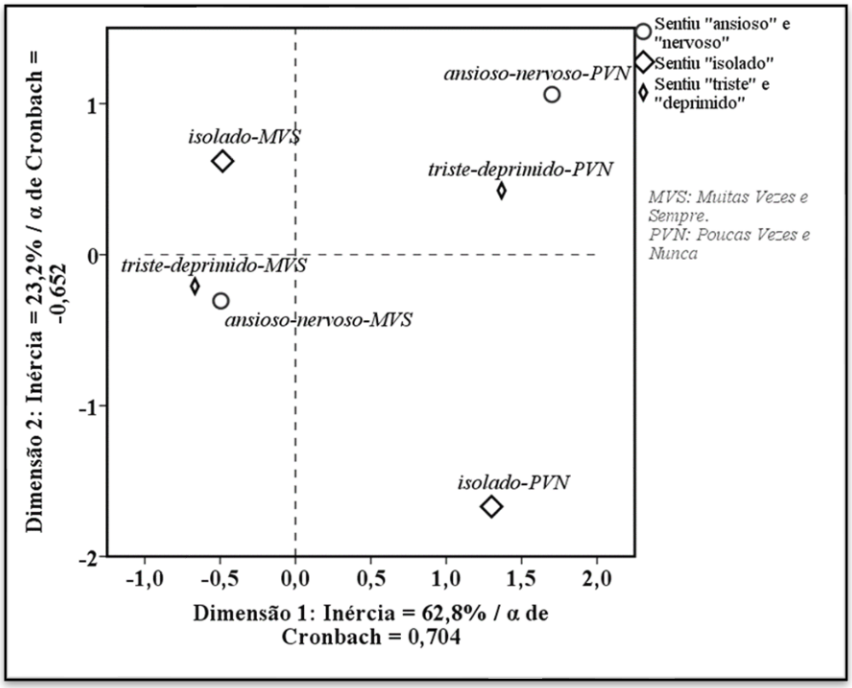
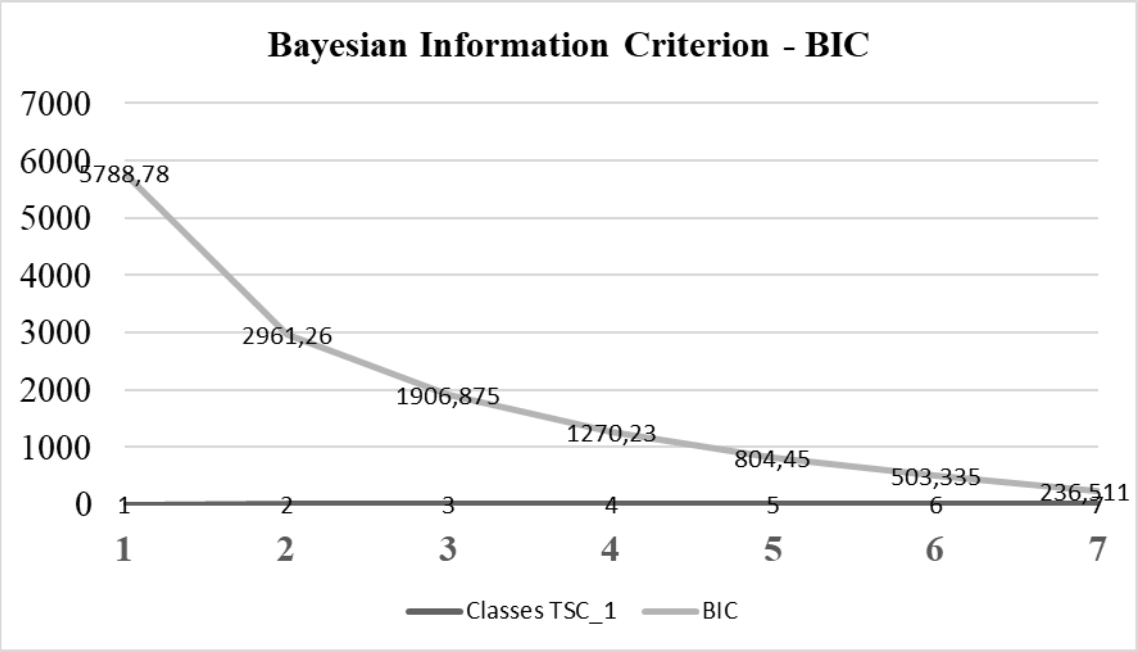


Image Source: Developed by the authors.

Two Step Cluster *Analysis*

The analysis used showed that the model with 7 classes (clusters) was more fit, with the best value of the separation and cohesion measure, and with the lowest BIC value, equal to 236.511 (Figure 2). This one took as reference the variable "anxiety and nervousness" (ordered in ascending order).

Figure 2 – Baysian Information Criterion *values* of the variation in the number of classes of the model referring to the Two *Step Cluster analysis*.



Legend: Measure of Cohesion and class separation = 1.0 (Good). And the size ratio between the classes with the highest and lowest prevalence was 13.65.
Image Source: Developed by the authors.

The prevalence of classes ranged from 4.0% to 54.7%. Thus, the ratio between the cluster with the highest and lowest prevalence was equal to 13.65. Table 1 shows the values of the prevalences of the classes, and the values of the prevalences of response to the item of each category of the variables "isolation", "sadness and depression" and "anxiety and nervousness".

Class 1 had a prevalence of 54.7% and the prevalence of responses to the items (categories) was 100% for the "Often/Always" option, showing that this can be considered the worst mental health condition. Class 4, on the other hand, had a prevalence of 11.2% and the answers of the categories were 100% for the "Few Times/Never" option, which shows that this situation is the best mental health condition. The other classes showed variation in the prevalence of MVS and PVN, a certain moderate mental health condition. Based on this, it was decided to separate this model with 7 classes into a variable with three categories related to mental health. Category 1 was "worse mental health", represented by class 1, 901 individuals (54.7%); 2 "moderate mental health", represented by classes 2, 3, 5, 6 and 7, with a total of 562 (34.1%); finally, the category "better mental health", referring to class 4, with 184 individuals (11.2%).

Table 1 **–** Characterization of the 7 classes generated by the *Two Step Cluster Analysis* and classification of the mental health of students and civil servants, as best, moderate and worst.

7 Classes generated by the TSC Model – γ: n (%) – 1647 (100%)

Manifest variables	*c 1: 901 (54.7%)	c 2: 103 (6.3%)	c 3: 139 (8.4%)	**c 4: 184 (11.2%)	c 5: 133 (8.1)	c 6: 66 (4.0%)	c 7: 121 (7.1%)
	Prevalence of the categories of manifest variables in each class – ρ (%)						
Insulation	*c1	c2	c3	**c4	c5	c6	c7
MVS	901 (100%)	103 (100%)	0(0%)	0 (0%)	133 (100%)	46 (69,7%)	121 (100%)
PVN	0 (0%)	0 (0%)	139 (100%)	184 (100%)	0 (0%)	20 (30,3%)	0(0%)
Sadness-Depression							
MVS	901 (100%)	0 (0%)	139 (100%)	0 (0%)	0 (0%)	66 (100%)	0(0%)
PVN	0 (0%)	103 (100%)	0(0%)	184 (100%)	133 (100%)	0 (0%)	121 (100%)
Anxiety-Nervousness							
MVS	901 (100%)	103 (100%)	139 (100%)	0 (0%)	133 (100%)	0 (0%)	0(0%)
PVN	0 (0%)	0 (0%)	0(0%)	184 (100%)	0 (0%)	66 (100%)	121 (100%)
Classification of classes	Worst SM	Moderate SM	Moderate SM	Best SM	Moderate SM	Moderate SM	Moderate SM

Legend: MVS: Often/Always; PVN: Few times/Never; SM: Mental Health; *c1 – represents the worst condition of MS; **c4 – represents the best condition of the SM.
Image Source: Developed by the authors.

Multinomial Regression

Based on the new variable generated by the TSC grouping, a multinomial regression analysis was performed with the objective of investigating the association between MS and sociodemographic variables, health status, routine behaviors, movement behaviors, sedentary behavior, sleep quality, social habits, and body mass index (BMI).

Table 2 presents the results of the multinomial regression considering the sociodemographic variables, health status, history related to COVID-19, and routine behaviors. Data show that individuals aged 60 years and older were 62.6% less likely to report a moderate MS condition (OR: 0.374; CI: 0.207–0.678; $p = 0.001$) and 77.7% less likely to report a worse MS condition, compared to the group with better mental health (OR: 0.223; CI: 0.125–0.398; $p < 0.001$), when compared to the age group up to 39 years. Participants between 40 and 59 years of age also had a lower risk: 44.9% less likely to have moderate MS (OR: 0.551; CI: 0.369–0.823; $p = 0.004$) and 83.2% less likely to have worse MS (OR: 0.168; CI: 0.109–0.259; $p < 0.001$). These findings reinforce that individuals up to 39 years of age were the most likely to have moderate or worse mental health conditions.

Regarding gender, men were 39.6% less likely to have moderate MS (OR: 0.604; CI: 0.429–0.850; $p = 0.004$) and 71.2% less likely to have worse MS (OR: 0.288; CI: 0.207–0.401; $p < 0.001$), when compared to women, indicating greater vulnerability of females to worsening mental status.

The economic situation was also relevant: individuals who had their income reduced or ceased were 2.65 times more likely to report moderate MS (OR: 2.657; CI: 1.348–5.238; $p = 0.005$) and 9.72 times more likely to report worse MS (OR: 9.724; CI: 4.579–20.652; $p < 0.001$), compared to those who reported an increase in income. Those who maintained their income were 3.28 times more likely to report worse MS (OR: 3.281; CI: 1.569–6.860; $p = 0.002$). In addition, individuals who did not receive the Emergency Aid had a lower risk of compromised MS: 44.9% less likely to have moderate MS (OR: 0.551; CI: 0.377–0.806; $p = 0.002$) and 67% less likely to have worse MS (OR: 0.330; CI: 0.230–0.475; $p < 0.001$), in relation to those who received the benefit.

Regarding health status, participants diagnosed with two or more chronic diseases were 2.88 times more likely to have moderate MS (OR: 2.885; CI: 1.351–6.163; $p = 0.006$) and 4.12 times more likely to have worse MS (OR: 4.120; CI: 1.969–8.620; $p < 0.001$), compared to those without a diagnosis. Having a single disease also increased the odds of compromised MS: 1.86-fold for moderate MS (OR: 1.862; CI: 1.056–3.283; $p = 0.032$) and 3.74 times for worse MS (OR: 3.747; CI: 2.187–6.420; $p < 0.001$).

People who reported having experienced severe cases of COVID-19 or deaths in the family or among friends were 1.85 times more likely to have worse MS (OR: 1.850; CI: 1.333–2.567; $p < 0.001$), compared to those who did not experience these situations.

Difficulties in routine and work/study also showed a significant association. Individuals with a lot of difficulty in the routine were 8.35 times more likely to have moderate MS (OR: 8.354; CI: 3.757–18.578; $p < 0.001$) and 49.92 times more likely to have worse MS (OR: 49.926; CI: 22.237–112.089; $p < 0.001$), while those who reported moderate difficulty in the routine were 2.25 times more likely to have moderate MS (OR: 2.255; CI: 1.512–3.365; $p < 0.001$) and 5.98 times more likely to have worse MS (OR: 5.985; CI: 3.827–9.360; $p < 0.001$), in relation to those who reported little difficulty.

Difficulties at work or in studies also considerably increased the risk of compromised MS: a lot of difficulty was associated with 7.40 times more chances of moderate MS (OR: 7.403; CI: 3.982–13.763; $p < 0.001$) and 30.57 times more likely to have worse MS (OR: 30.572; CI: 15.974–58.512; $p < 0.001$); while moderate difficulty increased the chance of moderate MS by 2.77 times (OR: 2.771; CI: 1.716–4.476; $p < 0.001$) and 5.08 times that of worse MS (OR: 5.088; CI: 3.000–8.628; $p < 0.001$), compared to those who had little difficulty.

Table 3 presents the results of the multinomial regression related to sleep quality, social habits, movement behaviors, sedentary behavior, and BMI. Participants who reported poor sleep quality were 3.95 times more likely to have moderate MS (OR: 3.952; CI: 2.686–

5.817; $p < 0.001$) and 13.48 times more likely to have worse MS (OR: 13.487; CI: 9.179–19.815; $p < 0.001$), compared to those with good sleep quality.

With regard to physical activity, not meeting the recommendations for moderate PA increased the odds of moderate MS by 1.51 times (OR: 1.519; CI: 1.021–2.259; $p = 0.039$) and 1.72 times the odds of worse MS (OR: 1.720; CI: 1.179–2.508; $p = 0.005$). On the other hand, non-adherence to vigorous PA increased the odds of moderate MS by 1.50 times (OR: 1.504; CI: 1.047–2.162; $p = 0.027$) and 1.78 times those of worse MS (OR: 1.787; CI: 1.264–2.526; $p = 0.001$).

Among sedentary behaviors, watching television for 4 hours or more increased the odds of worse MS by 1.94 times (OR: 1.941; CI: 1.109–3.396; $p = 0.002$). Computer or tablet use for 4 hours or more was associated with 1.59 times more odds of moderate MS (OR: 1.591; CI: 1.084–2.335; $p = 0.018$) and 2.13 times more likely to have worse MS (OR: 2.131; CI: 1.471–3.086; $p < 0.001$).

Finally, regarding BMI, individuals classified as overweight were 32% less likely to have worse MS when compared to eutrophic individuals (OR: 0.680; CI: 0.471–0.981; $p = 0.039$).

Table 2 – Multinomial regression of mental health correlated with sociodemographic variables, health status, COVID-19, and routine behaviors.

Medidas sociodemográficas, estado de saúde, COVID-19 e comportamentos de rotina	**Moderada Saúde Mental *versus* Melhor Saúde Mental**				**Pior Saúde Mental *versus* Melhor Saúde Mental**			
Faixa etária* (n = 1655)	**β**	**OR**	**IC95%**	***p***	**β**	**OR**	**IC95%**	***p***
60 anos ou mais	-0,983	0,374	0,207-0,678	0,001*	-1,501	0,223	0,125-0,398	<0,001*
40 a 59 anos	-0,596	0,551	0,369-0,823	0,004*	-1,781	0,168	0,109-0,259	<0,001*
Até 39 anos	1				1			
Sexo* (n = 1645)								
Masculino	-0,504	0,604	0,429-0,850	0,004*	-1,244	0,288	0,207-0,401	<0,001*
Feminino	1				1			
Renda* (n = 1633)								
Diminuiu ou ficou sem	0,977	2,657	1,348-5,238	0,005*	2,275	9,724	4,579-20,652	<0,001*
Manteve	0,401	1,493	0,773-2,882	0,233	1,188	3,281	1,569-6,860	0,002*
Aumentou	1				1			
Benefício do governo* (n = 1630)								
Não	-0,596	0,551	0,377-0,806	0,002*	-1,108	0,33	0,230-0,475	<0,001*
Sim	1				1			
Diagnóstico de doenças* (n = 1617)								
2 ou mais doenças	1,06	2,885	1,351-6,163	0,006*	1,416	4,12	1,969-8,620	<0,001*
1 doença	0,621	1,862	1,056-3,283	0,032*	1,321	3,747	2,187-6,420	<0,001*
Nenhuma doença	1				1			
Caso grave ou falecimento da família ou amigos pela COVID-19* (n = 1652)								
Sim	0,317	1,373	0,974-1,934	0,07	0,615	1,850	1,333-2,567	<0,001*
Não	1				1			
Dificuldades de rotina* (n = 1651)								
Muita dificuldade	2,123	8,354	3,757-18,578	<0,001*	3,911	49,926	22,237-112,089	<0,001*
Moderada dificuldade	0,813	2,255	1,512-3,365	<0,001*	1,789	5,985	3,827-9,360	<0,001*
Pouca dificuldade	1				1			
Dificuldades no trabalho/estudo* (n = 1652)								
Muita dificuldade	2,002	7,403	3,982-13,763	<0,001*	3,42	30,572	15,974-58,512	<0,001*
Moderada dificuldade	1,019	2,771	1,716-4,476	<0,001*	1,627	5,088	3,000-8,628	<0,001*
Pouca dificuldade	1				1			

Legend: n = total value of the sample for the variable; OR = Odds ratio; 95%CI = 95% confidence interval; variables that obtained statistically significant values p<0.05*. Image Source: Developed by the authors.

Table 3 – Multinomial regression of mental health correlated to the variables sleep, social habits, movement behaviors, sedentary behavior, and body mass index.

Sono, hábitos sociais, comportamentos de movimento, comportamento sedentário e índice de massa corporal	Moderada Saúde Mental *versus* Melhor Saúde Mental				Pior Saúde Mental *versus* Melhor Saúde Mental			
Qualidade do sono* (n = 1642)	**β**	**OR**	**IC95%**	***p***	**β**	**OR**	**IC95%**	***p***
Má qualidade	1,374	3,952	2,686-5,817	<0,001*	2,602	13,487	9,179-19,815	<0,001*
Moderada qualidade	0,791	2,205	0,612-7,944	0,227	1,141	3,128	0,866-11,301	0,082
Boa qualidade	1				1			
Bebida Alcoólica (n = 1616)								
Bebia	-0,26	0,771	0,539-1,102	0,154	-0,005	0,995	0,705-1,404	0,977
Não Bebia	1				1			
Fumo (n = 1603)								
Fumava	0,219	1,244	0,607-2,552	0,551	0,47	1,6	0,811-3,158	0,176
Não Fumava	1				1			
Caminhada (n = 1577)								
Não Atingiu	0,063	1,065	0,708-1,601	0,762	0,368	1,444	0,973-2,144	0,068
Atingiu	1				1			
AF Moderada* (n = 1574)								
Não atingiu	0,418	1,519	1,021-2,259	0,039*	0,542	1,72	1,179-2,508	0,005*
Atingiu	1				1			
AF Vigorosa* (n = 1515)								
Não atingiu	0,408	1,504	1,047-2,162	0,027*	0,581	1,787	1,264-2,526	0,001*
Atingiu	1				1			
Tempo de TV* (n = 1648)								
Elevado (≥ 4 horas)	0,307	1,359	0,753-2,452	0,309	0,663	1,941	1,109-3,396	0,02*
Não Elevado (< 4 horas)	1				1			
Tempo de Computador/Tablet* (n = 1650)								
Elevado (≥ 4 horas)	0,464	1,591	1,084-2,335	0,018*	0,756	2,131	1,471-3,086	<0,001*
Não Elevado (< 4 horas)	1				1			
IMC* (n = 1575)								
Obesidade	-0,435	0,647	0,379-1,107	0,112	-0,288	0,75	0,455-1,236	0,259
Sobrepeso	-0,182	0,834	0,570-1,220	0,35	-0,385	0,68	0,471-0,981	0,039*
Baixo peso	0,22	1,246	0,409-3,797	0,699	0,738	2,091	0,735-5,952	0,167
Eutrofia	1				1			

Legend: n = total value of the sample for the variable; OR = Odds ratio; 95%CI = 95% confidence interval; variables that obtained statistically significant values p<0.05*; PA = Physical Activity; TV = television; BMI = Body Mass Index. Image Source: Developed by the authors.

Variables with *a p-value* of less than 20% (*p<0.200*) in the previous analyses (Tables 2 and 3) were included in a new multinomial regression using the *backward* method. The consolidated results are presented in Table 4.

Individuals aged 60 years and older were 63.6% less likely to report a moderate mental health condition compared to the best MS condition (OR: 0.364; CI: 0.189–0.699; *p* = 0.002), and 77.8% less likely to report a worse MS condition than a better one (OR: 0.222; CI: 0.110–0.449; *p* < 0.001). Similarly, participants aged 40 to 59 years were 39.6% less likely to have moderate MS (OR: 0.604; CI: 0.380–0.960; *p* = 0.033) and 78.9% less likely to have worse MS (OR: 0.211; CI: 0.125–0.355; *p* < 0.001), when compared to the age group up to 39 years.

Regarding gender, male participants were 33.2% less likely to have moderate MS (OR: 0.668; CI: 0.462–0.967; *p* = 0.032) and 64.5% less likely to have worse MS (OR: 0.355; CI: 0.242–0.520; *p* < 0.001), compared to females.

With regard to income, individuals who had their income decreased or ceased were 2.13 times more likely to have moderate MS (OR: 2.133; CI: 1.015–4.481; *p* = 0.046) and 6.41 times more likely to have worse MS (OR: 6.418; CI: 2.639–15.608; *p* < 0.001), compared to those who had an increase in income. Those who maintained their income during the pandemic period were 3.98 times more likely to have worse MS (OR: 3.983; CI: 1.659–9.565; *p* = 0.002). In addition, individuals who did not receive the Emergency Aid were

49.2% less likely to report worse MS (OR: 0.508; CI: 0.322–0.800; $p = 0.003$), when compared to those who received the benefit.

The presence of chronic diseases was also a relevant factor: individuals diagnosed with two or more diseases were 3.44 times more likely to have moderate MS (OR: 3.446; CI: 1.510–7.867; $p = 0.003$) and 4.42 times more likely to have worse MS (OR: 4.424; CI: 1.907–10.263; $p = 0.001$), compared with those who had no diagnosis. Those with a single disease were 2.08 times more likely to have moderate MS (OR: 2.086; CI: 1.115–3.903; $p = 0.022$) and 4.72 times more likely to have worse MS (OR: 4.723; CI: 2.511–8.883; $p < 0.001$), in relation to those who did not have diseases.

Difficulties in the daily routine also showed a significant association. Individuals who reported a lot of difficulty in the routine were 4.14 times more likely to have moderate MS (OR: 4.147; CI: 1.635–10.524; $p = 0.003$) and 14.81 times more likely to have worse MS (OR: 14.811; CI: 5.671–38.679; $p < 0.001$), while those with moderate difficulty were 1.67 times more likely to have moderate MS (OR: 1.673; CI: 1.042–2.685; $p = 0.033$) and 3.48 times more likely to have worse MS (OR: 3.487; CI: 2.014–6.038; $p < 0.001$), compared to those who reported little difficulty in the routine.

In the academic and professional environment, the difficulties also negatively impacted mental health. Participants who reported a lot of difficulty at work or study were 3.43 times more likely to have moderate MS (OR: 3.437; CI: 1.665–7.095; $p = 0.001$) and 6.04 times more likely to have worse MS (OR: 6.045; CI: 2.730–13.384; $p < 0.001$). Those with moderate difficulty were 2.25 times more likely to have moderate MS (OR: 2.250; CI: 1.275–3.970; $p = 0.005$) and 2.83 times more likely to have worse MS (OR: 2.834; CI: 1.457–5.513; $p = 0.002$), in relation to those who indicated little difficulty.

Table 5 shows that sleep quality is one of the factors with the greatest weight in mental health. Participants who reported poor sleep quality were 3.90 times more likely to have moderate MS (OR: 3.902; CI: 2.520–6.043; $p < 0.001$) and 13.41 times more likely to have worse MS (OR: 13.414; CI: 8.673–20.747; $p < 0.001$), when compared to those who reported good sleep quality.

Finally, BMI also showed a significant association. Individuals classified as obese were 54% less likely to have moderate MS (OR: 0.460; CI: 0.247–0.855; $p = 0.014$) and 58.8% less likely to have worse MS (OR: 0.412; CI: 0.223–0.759; $p = 0.004$), compared to those classified as eutrophic.

In summary, the results indicated that female individuals up to 39 years of age, who reported reduced or maintained income during the pandemic, were more likely to be classified as having moderate or worse mental health conditions compared to those with

better mental health conditions. Other factors associated with compromised mental health included receiving government aid, previous diagnosis of one or more chronic non-communicable diseases, as well as moderate or severe difficulties in routine and work or study.

In addition, poor sleep quality, non-compliance with recommendations for moderate and vigorous physical activity, prolonged use (≥4h/day) of computer/tablet, and excessive television consumption were associated with poorer mental health. The experience of severe cases or deaths of family members or friends was also a relevant factor for the most negative outcome. Finally, the classification of normal weight by BMI, compared to obesity, was related to higher odds of moderate or worse mental health condition, suggesting possible associations between body composition and psychological distress in this context.

Table 4 – Multinomial regression of mental health correlated with sociodemographic variables, health status, and routine behaviors, which presented p<0.200 in Table 2.

Medidas sociodemográficas, estado de saúde e comportamentos de rotina	**Moderada Saúde Mental *versus* Melhor Saúde Mental**				**Pior Saúde Mental *versus* Melhor Saúde Mental**			
Faixa etária* (n = 1655)	**β**	**OR**	**IC95%**	***p***	**β**	**OR**	**IC95%**	***p***
60 anos ou mais	-1,011	0,364	0,189-0,699	0,002*	-1,505	0,222	0,110-0,449	<0,001*
40 a 59 anos	-0,504	0,604	0,380-0,960	0,033*	-1,557	0,211	0,125-0,355	<0,001*
Até 39 anos	1				1			
Sexo* (n = 1645)								
Masculino	-0,403	0,668	0,462-0,967	0,032*	-1,037	0,355	0,242-0,520	<0,001*
Feminino	1				1			
Renda* (n = 1655)								
Diminuiu ou ficou sem	0,757	2,133	1,015-4,481	0,046*	1,859	6,418	2,639-15,608	<0,001*
Manteve	0,432	1,541	0,749-3,172	0,24	1,382	3,983	1,659-9,565	0,002*
Aumentou	1				1			
Benefício do governo* (n = 1630)								
Não	-0,365	0,694	0,442-1,089	0,112	-0,678	0,508	0,322-0,800	0,003*
Sim	1				1			
Diagnóstico de doenças* (n = 1617)								
2 ou mais doenças	1,237	3,446	1,510-7,867	0,003*	1,487	4,424	1,907-10,263	0,001*
1 doença	0,735	2,086	1,115-3,903	0,022*	1,552	4,723	2,511-8,883	<0,001*
Nenhuma doença	1				1			
Dificuldades de rotina* (n = 1651)								
Muita dificuldade	1,423	4,147	1,635-10,524	0,003*	2,695	14,811	5,671-38,679	<0,001*
Moderada dificuldade	0,515	1,673	1,042-2,685	0,033*	1,249	3,487	2,014-6,038	<0,001*
Pouca dificuldade	1				1			
Dificuldades no trabalho/estudo* (n = 1652)								
Muita dificuldade	1,235	3,437	1,665-7,095	0,001*	1,799	6,045	2,730-13,384	<0,001*
Moderada dificuldade	0,811	2,25	1,275-3,970	0,005*	1,042	2,834	1,457-5,513	0,002*
Pouca dificuldade	1				1			

Legend: n = total value of the sample for the variable; OR = Odds ratio; 95%CI = 95% confidence interval; variables that obtained statistically significant values p<0.05*. Image Source: Developed by the authors.

Table 5 – Multinomial regression of mental health correlated with the variables sleep, social habits, movement behaviors, sedentary behaviors, and body mass index, which presented p<0.200 in Table 3.

Sono, hábitos sociais, comportamentos de movimento, comportamentos sedentários e índice de massa corporal	Moderada Saúde Mental *versus* Melhor Saúde Mental				Pior Saúde Mental *versus* Melhor Saúde Mental			
Qualidade do sono* (n = 1642)	**β**	**OR**	**IC95%**	***p***	**β**	**OR**	**IC95%**	***p***
Má qualidade	1,362	3,902	2,520-6,043	<0,001*	2,596	13,414	8,673-20,747	<0,001*
Moderada qualidade	1,277	3,588	0,782-16,451	0,1	1,232	3,428	0,708-16,596	0,126
Boa qualidade	1				1			
Bebida Alcoólica (n = 1616)								
Bebia	-0,349	0,706	0,465-1,070	0,101	-0,172	0,842	0,553-1,282	0,423
Não Bebia	1				1			
Fumo (n = 1603)								
Fumava	0,24	1,272	0,571-2,832	0,556	0,27	1,309	0,593-2,892	0,505
Não Fumava	1				1			
Caminhada (n = 1577)								
Não Atingiu	-0,308	0,735	0,432-1,251	0,256	-0,013	0,987	0,575-1,695	0,963
Atingiu	1				1			
AF Moderada (n = 1574)								
Não atingiu	0,258	1,294	0,771-2,173	0,329	0,154	1,167	0,692-1,967	0,563
Atingiu	1				1			
AF Vigorosa (n = 1515)								
Não atingiu	0,327	1,387	0,888-2,166	0,15	0,405	1,499	0,955-2,354	0,078
Atingiu	1				1			
Tempo de TV (n = 1648)								
Elevado (≥ 4 horas)	-0,01	0,99	0,492-1,992	0,979	0,193	1,213	0,612-2,403	0,58
Não Elevado (< 4 horas)	1				1			
Tempo de Computador/Tablet (n = 1650)								
Elevado (≥ 4 horas)	0,351	1,421	0,919-2,195	0,114	0,419	1,52	0,977-2,365	0,064
Não Elevado (< 4 horas)	1				1			
IMC* (n = 1575)								
Obesidade	-0,778	0,46	0,247-0,855	0,014*	-0,888	0,412	0,223-0,759	0,004*
Sobrepeso	-0,113	0,893	0,580-1,375	0,608	-0,372	0,689	0,445-1,068	0,096
Baixo peso	-0,183	0,833	0,259-2,679	0,759	0,016	1,016	0,326-3,165	0,978
Eutrofia	1				1			

DISCUSSION

The MCA performed in this study showed a moderate association between feelings of sadness-depression and anxiety-nervousness, indicating that individuals who reported feeling such emotions more frequently tend to experience them simultaneously. Similar patterns were observed in a study conducted with university students, in which the practice of physical activity was associated with mental health stability, while changes in behavioral habits during the pandemic were related to an increase in negative feelings, such as loneliness, stress, anxiety, and frustration, as well as a reduction in sleep time (Merchán-Sanmartín et al., 2022). In addition, anxious and depressive symptoms may be associated with both COVID-19 infection and the subsequent period, suggesting the persistence of psychological distress even after the critical event and the possibility of progression to mental disorders (Huyut; Soygüder, 2022).

The second stage of the results refers to the categorization of mental health through the grouping generated by the TSC. Similar results were observed in a multicenter study conducted with university students from different countries, in which mental health was also categorized, and greater impairment was identified among women and individuals not engaged in physical activities or sports clubs (Wattanapisit et al., 2022). In a convergent way, a study with Canadian adults that employed a similar grouping methodology pointed to greater vulnerability to mental health in younger individuals, females, with lower incomes, poorer sleep quality, and perceived declining health during the pandemic (Richardson et al., 2022).

The results of the regressions indicated that individuals up to 39 years of age were more likely to be classified as having the worst mental health condition. These findings are

in line with studies conducted during the COVID-19 pandemic, which showed greater psychological impairment among young adults, reporting emotional overload and greater susceptibility to mental distress (Pieh; Budimir; Probst, 2020). In Brazil, there was a higher prevalence of anxious and depressive symptoms among young people, compared to the elderly population, corroborating the findings of this study, highlighting the importance of early identification of these symptoms as a strategy to prevent the worsening of psychological distress (Puccinelli et al., 2021).

Evidence showed that women were more likely to report worse mental health conditions compared to men. Studies carried out with the Brazilian population corroborate these findings, by pointing to a higher frequency of feelings of sadness-depression and anxiety-nervousness, as well as higher rates of depressive and anxious symptoms among females (Malta et al., 2020b; Puccinelli et al., 2021). On the other hand, a meta-analysis identified that men significantly increased the time in sedentary behavior during the pandemic, which negatively impacted quality of life and mental health indicators, increasing the propensity for symptoms of depression and anxiety (Runacres et al., 2021). Such evidence suggests that both sexes were psychologically affected, although by different mechanisms.

Regarding socioeconomic status, it was observed that individuals who maintained, reduced or lost their income, as well as those who received the Government's Emergency Aid, were more likely to report worse mental health conditions. A study carried out in Brazil showed that financial instability and the consequent reduction in family income were aggravating factors for anxious and depressive symptoms during the pandemic (Malta et al., 2020a; Feter et al., 2021), and this association has also been identified in populations from China (Cao et al., 2020) and the United States (Rudenstine et al., 2021). Although the emergency benefit reached part of the population, its granting was not sufficient to contain the impacts of poverty, maintaining the levels of vulnerability and financial insecurity, which may have contributed to psychological suffering (Lima et al., 2021; Malta et al., 2020a).

The study in question showed that individuals diagnosed with one or more pre-pandemic NCDs were more likely to deteriorate their mental health. Research on Brazilians with NCDs revealed an increase in the incidence of feelings of sadness, depression, anxiety, and nervousness during the pandemic (Lima et al., 2022), corroborating our findings. Another study highlights that the worsening lifestyle of the Brazilian population, with reduced physical activity and increased sedentary behavior, may have contributed to the worsening of mental health indicators and mortality due to NCDs in this period (Malta et al., 2021). However, one survey found no significant association between perceived stress

and the number of NCDs diagnosed, suggesting that the perception of stress was widespread among the population during the pandemic, regardless of the presence of chronic diseases (Nordgren et al., 2022).

It was observed that individuals who experienced the loss of family members or friends due to COVID-19 were more likely to have their mental health deteriorate. The pandemic, characterized by unexpected, unfair, and rapid deaths, has exposed the bereaved to psychological burdens such as anger, depression, anxiety, and complicated grief (Tang et al., 2021). The mass loss of loved ones in the same family nucleus was also associated with even more intense psychological distress (Bajwah et al., 2020). In Brazil, the high number of deaths caused significant transformations and various forms of suffering (Dantas et al., 2020). The anguish resulting from separation, whether due to death or forced distancing, as well as stress, can signal functional impairment, serving as an indication of mental disorders (Breen; Lee; Neimeyer, 2021). These elements corroborate our findings that grief, especially when it involves unexpected losses, can cause serious psychic damage.

Our results indicated that individuals with difficulties in maintaining their work or study routine had worse mental health conditions. Similar studies have pointed out that quarantine and social distancing have altered routines, triggering feelings of depression, anxiety, and distress (Szwarcwald et al., 2021b). Changes in work and academic activities, added to remote work and study, have favored the decline in mental health, generating mental fatigue and technological stress due to e-learning (Allam et al., 2021). Working from home was associated with a higher perception of stress among academics, faculty, and staff (Heiden et al., 2021), with increased mental distress in universities (Allam et al., 2021; Heiden et al., 2021). A study with teachers from Minas Gerais corroborated these findings, showing an increase in stress and dissatisfaction with work (Silva et al., 2021b). Similarly, college students also reported high levels of anxiety, depression, and stress, due to changes in the study environment and online assignments, as well as concerns about their career and future (Coakley et al., 2021).

Poor sleep quality was associated with a greater perception of deteriorating mental health. Studies with Brazilians corroborate these findings, indicating that impaired sleep during the pandemic was related to feelings of loneliness, sadness, depression, and anxiety (Werneck et al., 2021b; Bedim et al., 2024a), in addition to worse emotional health and greater predisposition to sleep disorders (Lima et al., 2021). Negative changes in sleep quality have also been linked to worsening psychological distress (STANTON et al., 2020).

Poor sleep quality correlated with elevated symptoms of depression and anxiety, and the subsequent development of these disorders (Alimoradi et al., 2021).

We observed that individuals who did not meet the recommendations for moderate physical activity (MPA) and vigorous physical activity (VPA) had worse mental health conditions. According to related studies, low physical activity and non-adherence to the recommendations of 150 minutes per week of PA were associated with worsening mental health, with a prevalence of feelings of loneliness, sadness, depression, and anxiety (Werneck et al., 2020a; Werneck et al., 2021c; Bedim et al., 2024b) and increased anxiety and depressive symptomatology (Feter et al., 2021). On the other hand, physically active individuals, who met PA recommendations, had lower levels of anxiety and better mental health conditions (Reyes-MOLINA et al., 2022). In addition, minimum daily practice of 15 minutes of AFV or AFM was associated with a lower prevalence of depression, anxiety, and co-occurring symptoms of these conditions (Schuch et al., 2020).

The results indicated that individuals with high screen time (≥4h/day) on TV and/or computer/tablet had worse MS conditions. A similar study with Brazilian adults identified that TV consumption for 4 hours or more correlated with worse mental health conditions, with a prevalence of loneliness, sadness, and anxiety, regardless of a previous diagnosis of depression (Werneck et al., 2021a; Werneck et al., 2020b; Werneck et al., 2021c). Thus, increased sitting and screen time was related to negative MS and reduced feelings of well-being (Reyes-Molina et al., 2022). Making valid the need to monitor such behaviors, in order to prevent mental disorders in the long term.

We observed that overweight and obese individuals, according to BMI, had lower chances of worsening mental health compared to eutrophic individuals. These findings contradict usual expectations, evidencing the need for caution in generalizations about body weight, in addition to highlighting the relevance of considering a broader set of variables associated with this health indicator. Lifestyle changes during the pandemic resulted in changes in body weight, which, although not enough to change the BMI classification, led to an increase in psychological distress (Ahmad et al., 2022). This finding may contribute to the explanation of our results, although future research is needed to assess the impact of these changes on the mental health of the Brazilian population.

Our results indicated that alcohol and tobacco consumption were associated with lower odds of mental health deterioration, in contrast to individuals who did not consume these substances. A similar study suggested that social alcohol consumption can have positive effects on emotions, with emotional problems being restricted to cases of abuse (Ingram; Maciejewski; Hand, 2020). However, research on the Brazilian population revealed

an increase in alcohol consumption during the pandemic, correlated with psychological distress and financial difficulties (Malta et al., 2021). These discrepancies may be due to differences in the samples studied, since our research focused on university students, whose alcohol consumption habits in social and leisure contexts were impacted by the pandemic.

This study has several strengths, such as the diversified sample, including participants from various regions of Brazil, and the scope of the variables analyzed, which allow us to explore the influences on MS. In addition, it is the first to use a multivariate approach with clusters to classify MS and investigate feelings of loneliness, sadness-depression, and anxiety-nervousness during the pandemic, employing a wide range of variables.

However, some limitations must be considered. The study, being cross-sectional and observational, does not allow inferring causality. In addition, the use of self-reported questionnaires may be subject to recall bias, overestimation of physical activity, and underestimation of sedentary behavior. The online search limited the evaluation of particularities, the absence of objective evaluations of symptoms of mental disorders and the exclusion of the use of psychotropic drugs may be limitations.

CONCLUSION

The multivariate assessment of MS in the academic population identified three classifications: best, moderate, and worst MS. It was observed that young, female individuals with changes in income, pre-pandemic diagnosis of NCDs, loss of friends or family members due to COVID-19, difficulties in routine and work/study, poor sleep quality, non-adherence to the recommendations of AFM and AFV, eutrophic and with excessive use of screens (≥4 hours) were more likely to fall into the category of worst MS during the pandemic.

It is concluded that changes in behaviors and lifestyle, resulting from social isolation, the technological adaptations of the University and the socioeconomic impacts of the pandemic, exacerbated negative perceptions, affecting the MS of the population studied. In this context, the need for policies that encourage the practice of PA, the reduction of sedentary behavior, the reduction of time in front of screens, the improvement of sleep hygiene, the adoption of healthy habits, the taking of breaks during work and the use of strategies such as mindfulness and psychological monitoring to preserve positive MS is highlighted.

It is recommended the implementation of intersectoral and multidisciplinary institutional actions, with the dissemination of practices to preserve MS, aiming to mitigate the physical and mental impacts of COVID-19 and ensure the continuity of health. Future longitudinal studies are needed to guide more effective interventions and to deepen the understanding and causal relationship between MS, habitual, movement, sedentary behaviors, sleep, and socioeconomic characteristics.

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