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Original Article

Dietary Patterns, Food Cravings and Academic Stress in Mexican University Students during COVID-19 Lockdown: A Cross-Sectional Study

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Abstract

Background and objectives: The COVID-19 pandemic profoundly impacted university students, presenting multifaceted challenges including the abrupt transition to virtual learning and significant disruptions to emotional well-being and dietary habits. This study aimed to investigate the dietary and nutritional characteristics associated with academic stress among Mexican university students during the COVID-19 lockdown.

Methods: This cross-sectional study was conducted with a sample of 114 university students in Mexico. Participants completed a self-reported questionnaire assessing dietary patterns, nutritional intake, and academic stress levels. Informed consent was obtained from all participants prior to data collection.

Results: Among study participants (n = 114), 57.8% experienced moderate academic stress, while 25.7% reported high academic stress during the COVID-19 lockdown. Notably, 13.5% of students demonstrated food cravings that were significantly associated with increased consumption of red and fatty meats ($P = 0.030$) and sausages ($P = 0.017$). A negative virtual education experience was associated with food cravings towards high-calorie and saturated-fat foods ($P = 0.014$), as well as elevated academic stress levels ($P = 0.009$). Furthermore, high academic stress levels were positively associated with food cravings ($P = 0.020$), particularly towards carbohydrate-rich foods ($P = 0.037$).

Conclusions: The COVID-19 lockdown substantially disrupted the dietary habits and nutritional status of university students, with academic stress serving as a significant mediating factor.

Introduction

The COVID-19 pandemic profoundly disrupted multiple dimensions of university students' lives, encompassing both personal and academic domains.[1] During the lockdown, students encountered unprecedented challenges associated with distance learning, including the abrupt transition to virtual educational modalities and significantly increased academic stress.[2] The sudden shift to virtual education had particularly pronounced emotional consequences. Students experienced heightened emotional distress characterized by work overload, adaptive challenges, and pervasive uncertainty about their academic trajectories.[3,4] This unprecedented educational environment generated complex emotional stressors that fundamentally altered students' academic and personal experiences.

Moreover, the lockdown substantially modified students' dietary habits and lifestyle patterns. Researchers observed a notable increase in unhealthy food consumption, accompanied by decreased physical activity and reduced sleep duration.[5] These comprehensive behavioral modifications were potentially linked to stress management and overall student well-being during the

Keywords: Food preferences; COVID-19 lockdown; Academic stress; Feeding behavior; Virtual education; Dietary habits; University students; Food cravings; Mexico.
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pandemic. The biopsychosocial dynamics underlying these behavioral changes were multifaceted. Diminished sleep quality, persistent feelings of isolation, heightened worry and frustration, and increased anxiety and depression levels manifested in greater "food cravings". Such behavioral patterns represent significant risk factors for developing obesity and chronic non-communicable diseases, including diabetes and cardiovascular conditions.[6]

In the Mexican context, while existing literature has explored the pandemic's emotional health implications for university students, research explicitly examining how academic stress and virtual education affected dietary patterns and lifestyle remains limited.[7,8] Consequently, this study aimed to investigate the dietary and nutritional characteristics associated with academic stress and virtual education among university students in Nayarit, Mexico, during the COVID-19 lockdown.

Material and methods

Study design and participants

This retrospective cross-sectional study involved health sciences students from the Autonomous University of Nayarit, Mexico, during the COVID-19 lockdown. The research was conducted collaboratively with the Laboratory of Nutritional Consultation at the Integral Health Academic Unit, Autonomous University of Nayarit, and the Specialized Unit in Research, Development, and Innovation in Genomic Medicine, Nayarit Center for Innovation and Technology Transfer, both located in Tepic, Nayarit.

The main eligibility criteria included: (i) active university students over 18 years of age enrolled in health sciences programs, (ii) body mass index (BMI) of at least 18.5 kg/m^2, and (iii) completion of all coursework exclusively through virtual education during the COVID-19 home confinement period (August to December 2020 and January to July 2021). Participants were excluded with incomplete data, if they took a leave of absence during the specified timeframe, were pregnant or breastfeeding, or reported pre-existing emotional disturbances (such as anxiety or depression) prior to the study period. The research was conducted from August 2021 to December 2022.

Data collection instruments

Data were collected through a comprehensive online survey designed to capture participants' sociodemographic characteristics, dietary habits, and perceptions of the virtual educational environment. Dietary intake was evaluated using a validated food frequency questionnaire specifically developed for the Mexican adult population.[9] Participants' dietary patterns were subsequently categorized into food groups based on primary macronutrient sources: cereals, fruits and vegetables, dairy products, processed food and sweets, legumes and oilseeds, red and fatty meats, and withe meats.

Two validated instruments were employed to assess participants' eating behaviors: (i) the Food Craving Questionnaire-Trait, a validated tool for the Mexican population measuring the frequency and intensity of food cravings in response to emotional triggers,[10] and (ii) the Food Craving Inventory, designed for the general population.[11] For this study, the Food Craving Questionnaire-Trait score was the primary focus. Participants scoring ≥ 123 points were identified as experiencing significant food cravings.

The Academic Stress Questionnaire at the University was utilized to evaluate potential stress sources specific to the virtual university setting.[12] Participants scoring ≥ 32 points were classified as experiencing high academic stress. The research also conducted a comprehensive evaluation of students' emotional well-being, with particular emphasis on assessing anxiety, depression, and insomnia during the COVID-19 pandemic.

Ethical considerations

This study received ethical approval from the Local Health Research and Ethics Committee of the Mexican Social Security Institute (Approval Number: R/2021/1801/017), ensuring rigorous protection of participants' rights and well-being throughout the research process. All study procedures were meticulously conducted in full compliance with the updated Declaration of Helsinki, as adopted at the 64th World Medical Association General Assembly in Fortaleza, Brazil, in 2013.[13]

Statistical analyses

Statistical analyses were performed using SPSS Statistics software (version 25.0 for Windows; IBM Corp., Chicago, IL, United States). The normality of quantitative variables was initially assessed using the Kolmogorov–Smirnov test. Quantitative variables were expressed as mean ± standard deviation (minimum–maximum), and categorical variables were reported as frequencies (*n*) and percentages (*%*). Parametric tests such as Student's t-test and one-way analysis of variance (ANOVA) with subsequent post hoc tests, were applied to quantitative variables demonstrating normal distribution. Non-parametric tests such as the Kruskal–Wallis test were utilized for variables with non-normal distributions. The Chi-square test and Fisher's exact test were employed for categorical variables. Multiple linear regression models were constructed to assess associations between dependent and independent variables. Logistic regression models were used to analyze binary outcomes. All regression models were adjusted for potential confounding variables, including age, sex, BMI, and waist circumference, where appropriate. Results are presented as beta coefficients (β) with 95% confidence intervals (CI) for linear regression, and odds ratios (OR) with 95% CI for logistic regression. A two-tailed *P*-value of <0.05 was considered statistically significant.

Results

A total of 328 surveys were distributed via university email lists to eligible students. Of these, 156 responses were received. After applying selection criteria, 42 students were unable to participate in the study for the following reasons: failure to meet inclusion criteria (n = 26) and incomplete data (n = 16). The final analytical sample comprised 114 students (Fig. 1).

Description of clinical characteristics and perception of virtual education

The study comprised 114 university students with a mean age of 22.0 ± 3.4 years, ranging from 19 to 50 years. The sample was predominantly female (84.0%), with 77.0% of participants reporting a normal weight during the COVID-19 lockdown period. Regarding perceptions of the virtual educational experience, a majority of students (58.8%) reported feeling overwhelmed by the virtual workload, while 39.5% expressed a lack of motivation to participate in online classes. During the confinement period, students experienced notable emotional distress: 34.2% reported feelings of anxiety, and 24.6% reported insomnia (Table 1). The Global Physical Activity Questionnaire, a World Health Organization–validated instrument used across multiple populations,[14] was administered

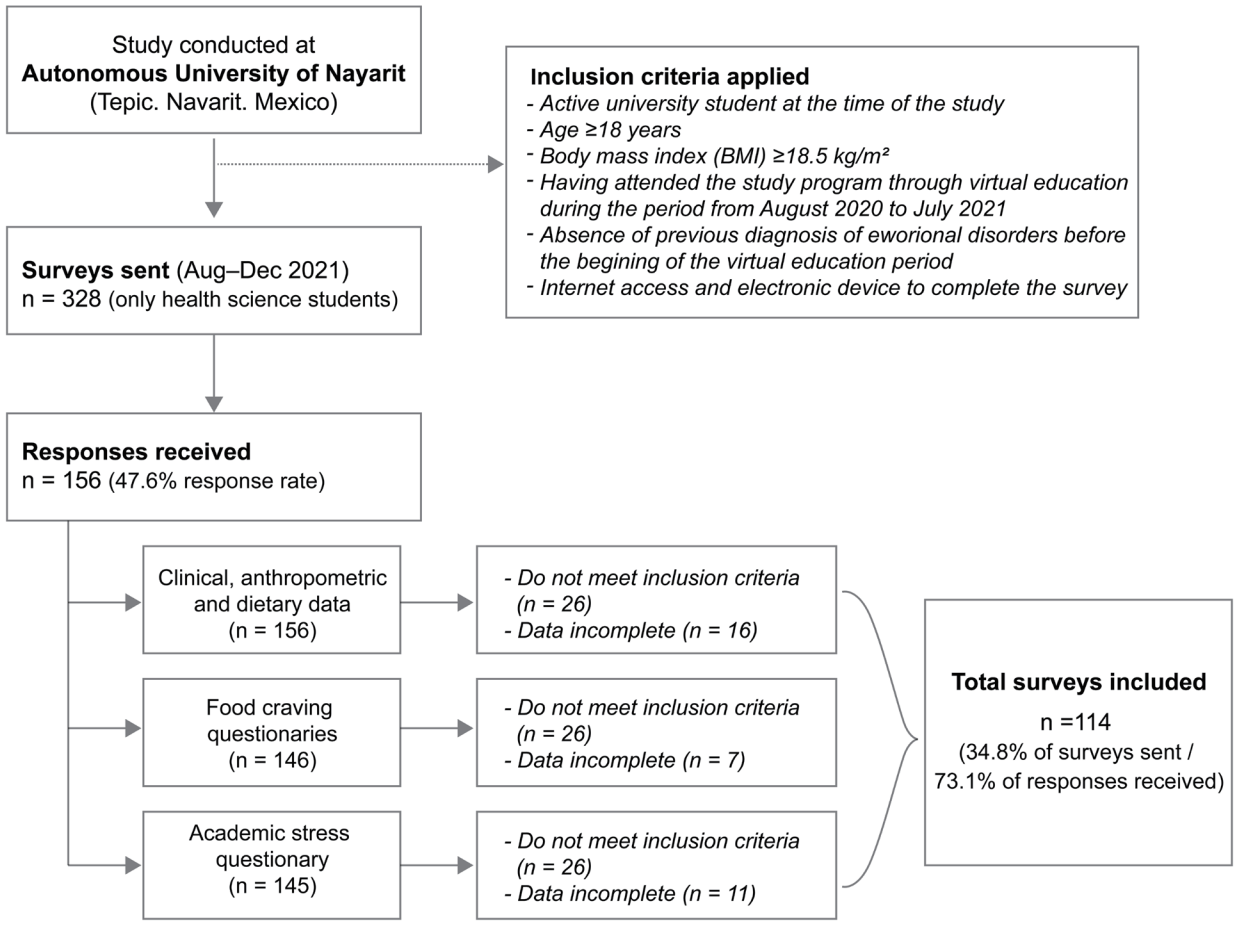

Fig. 1. Flowchart of participant recruitment and selection process. Participant flow diagram showing recruitment, response rates, and exclusions for the cross-sectional study. Numbers indicate participants at each stage, with percentages calculated from initial surveys sent (n = 328) and total responses received (n = 156).

to evaluate physical activity. However, no relevant data were obtained from this assessment (data not shown).

Association between academic stress levels and food cravings among university students

Analysis of academic stress patterns revealed that a substantial proportion of university students experienced elevated stress levels during education under the COVID-19 lockdown. As shown in Table 1, 56.1% (n = 64) of students reported moderate stress levels, while 27.2% (n = 31) experienced high levels of academic stress while enrolled in virtual classes.

During the lockdown period, 13.5% (n = 15) of participating students exhibited food cravings. Students with food cravings demonstrated markedly higher consumption of red and fatty meats (33.3%) compared to those without cravings (10.4%), a statistically significant difference ($P = 0.030$). Notably, processed foods and sweets consumption showed a distinct pattern: 26.7% of students with cravings reported intake, while no consumption was reported among students without cravings ($P = 0.001$). Additionally, the data suggested a trend toward increased cereal consumption among students with food cravings (73.3%) compared to those without cravings (47.9%), although this difference approached but did not reach statistical significance ($P = 0.095$) (Table 2).

Association between virtual educational environment, dietary characteristics, and academic stress levels

Table 3 highlights dietary characteristics and academic stress associated with the virtual educational environment experience. Of the total participants, 32.7% (n = 37) reported a negative experience with virtual education during the COVID-19 lockdown. These students demonstrated a notable trend toward increased food cravings compared to those with positive perceptions (21.6% vs 9.3%, $P = 0.084$). A particularly significant finding emerged regarding the consumption of energy-dense, high–saturated fat foods: students reporting negative experiences showed markedly higher intake levels (8.6 ± 4.4) compared to their counterparts with positive experiences (6.8 ± 3.0, $P = 0.014$). Conversely, students who maintained a favorable view of their virtual education experience exhibited lower consumption of calorie-dense, high–saturated fat foods and demonstrated reduced food craving levels (Table 3).

The relationship between virtual education perception and academic stress levels was particularly noteworthy. Students expressing negative perceptions of their virtual education experience exhibited significantly higher levels of academic stress compared to those reporting positive experiences (42.9% vs 17.6%, $P = 0.009$). However, the analysis revealed no statistically significant differences in food group consumption patterns based on students' per-

Table 1. Clinical characteristics, academic stress levels, and virtual educational perceptions among university students during the COVID-19 Lockdown

Variables	Study population
Total participants (n)	114
Age (years)	22.0 ± 3.4 (19–50)
Male, n (%)	18 (15.8%)
Female, n (%)	96 (84.2%)
BMI (kg/m^2)	23.0 ± 3.5 (18.6–35.1)
BMI 18.5 - 24.9 kg/m^2, n (%)	87 (77.0%)
BMI ≥ 25 kg/m^2, n (%)	26 (23.0%)
Waist circumference (cm)	73.2 ± 10.2 (59–105)
Academic stress levels	
Low, n (%)	19 (16.7%)
Moderate, n (%)	64 (56.1%)
High, n (%)	31 (27.2%)
Perception of the virtual educational environment	
Overwhelmed by virtual school workload, n (%)	67 (58.8%)
Poor recognition and no contact with peers, n (%)	49 (43.0%)
No motivation to join virtual classes, n (%)	45 (39.5%)
Unsatisfactory experience with virtual education, n (%)	23 (20.2%)
Poor distribution of time in virtual education, n (%)	18 (15.8%)
Emotional perception	
Anxiety Perception, n (%)	39 (34.2%)
Insomnia Perception, n (%)	28 (24.6%)
Depression perception, n (%)	18 (15.8%)

The values are presented as mean ± standard deviation (minimum-maximum), frequency (*n*), and percentage (%). BMI, body mass index.

ceived virtual educational experience during the lockdown period (Table 3).

Association between academic stress levels, food cravings, and virtual educational experience

Analysis of the relationship between nutritional characteristics, the virtual educational environment, and academic stress levels revealed significant patterns among university students, as presented in Table 4. Students reporting high academic stress levels demonstrated markedly elevated frequencies of food cravings (29.6%) compared to those with low (5.6%) and moderate (9.7%) stress levels (P = 0.020). These highly stressed students showed a significant preference towards foods rich in complex carbohydrates and proteins (17.5 ± 5.1) compared to their counterparts with low

Table 2. Association of high dietary intake† across food groups with food craving frequency among university students during the COVID-19 lockdown

Variables	Without food craving	With food craving	*P*-value	Adjusted OR (95% CI)	*P*-value
n = 111	96 (86.5%)	15 (13.5%)			
Cereals, n (%)	46 (47.9%)	11 (73.3%)	0.095	3.79 (0.818–17.594	0.089
Fruits and Vegetables, n (%)	39 (40.6%)	6 (40.0%)	1.000*	1.48 (0.406–5.400)	0.552
Dairy products, n (%)	3 (3.1%)	0 (0.0%)	1.000*	–	–
Processed foods and sweets, n (%)[C]	0 (0.0%)	4 (26.7%)	0.001*	8.95 (2.124–37.781)	0.003
Legumes and oilseeds, n (%)	2 (2.1%)	0 (0.0%)	1.000*	–	–
Red and fatty meats, n (%)	10 (10.4%)	5 (33.3%)	0.030*	4.50 (1.084–23.029)	0.039
White meats, n (%)	9 (9.4%)	2 (13.3%)	0.642*	1.21 (0.120–12,176)	0.873

The values are presented as frequency (*n*) and percentage (%). †High dietary intake = consumption 3 times or more per day. *Fisher's exact test was used for all comparisons due to small expected cell frequencies (<10 cases). Association analyses were adjusted for age and sex. [C]Includes sugars and sugary drinks, cookies and snacks, and sausages. Adjusted OR obtained through logistic regression models adjusted for age and sex. – indicates analysis not performed due to zero cases in one group. CI, confidence intervals; OR, odds ratios.

Table 3. Association of dietary characteristics and academic stress levels with positive experiences in the virtual educational environment among university students during the COVID-19 lockdown

Variables	Virtual educational environment		*P*-value	Adjusted β or OR (95% CI)	*P*-value
	Positive experience	Negative experience[†]			
n = 113	76 (67.3%)	37 (32.7%)			
Food craving, n (%)	7 (9.3%)	8 (21.6%)	0.084*	OR:1.96 (0.525–7.794)	0.317
Towards foods high in simple sugars and trans fats	17.51 ± 8.9	19.6 ± 10.1	0.263	β: 2.09 (−1.674–5.797	0.268
Towards foods high in complex carbohydrates and proteins	14.68 ± 6.1	15.3 ± 5.9	0.614	β: 0.62 (−1.890–3.131	0.626
Towards foods high in calories and saturated fat	6.8 ± 3.0	8.6 ± 4.4	0.014	β:1.82 (0.365–3.281)	0.015
Mean food groups					
Cereals	39 (51.3%)	18 (48.6%)	0.474	OR: 0.82 (0.341–1.955)	0.649
Fruits and vegetables	33 (43.4%)	13 (35.1%)	0.423	OR: 0.89 (0.365–2.167)	0.796
Red and fatty meats	10 (13.2%)	5 (13.5%)	1.000*	OR: 0.84 (0.234–2.988)	0.782
White meats	8 (10.5%)	3 (8.1%)	1.000*	OR: 0.73 (0.134–3.987)	0.718
Processed foods	0 (0.0%)	2 (5.4%)	0.105*	–	–
Academic stress levels					
Low, n (%)	16 (21.6%)	2 (5.7%)	0.051*	OR: 0.18 (0.037–0.922)	0.040
Moderate, n (%)	45 (60.8%)	18 (51.4%)	0.409	OR: 0.65 (0.263–1.580)	0.337
High, n (%)	13 (17.6%)	15 (42.9%)	0.009	OR: 4.91 (1.735–13.869)	0.003

The values are presented as mean ± standard deviation unless otherwise reported as frequency (n) and percentage (%). [†]Negative Experience = three or more negative answers to the five items that evaluated the perception of the virtual educational environment (see Table 1). The Student's t-test and Chi-Square test were the statistical methods. *Fisher's exact test was used for all comparisons due to small expected cell frequencies (<10 cases). Adjusted analyses were obtained through multiple linear regression (β coefficients) or logistic regression (OR) models, which were adjusted for age, sex, BMI, and waist circumference. – indicates analysis not performed due to zero cases in one group. CI, confidence intervals; OR, odds ratios.

(13.7 ± 6.1) and moderate (14.7 ± 6.2) stress levels (P = 0.037). Additionally, they exhibited a notable tendency toward consuming high-calorie and saturated fat foods (8.9 ± 3.5) compared to students with low (6.7 ± 3.6) and moderate (7.1 ± 3.6) stress levels (P = 0.055) (Table 4).

The impact of stress levels extended beyond dietary patterns to affect students' engagement with virtual education. Students experiencing high academic stress reported significantly higher rates of feeling overwhelmed by the virtual workload (75.0%) compared to those with low (38.9%) and moderate (57.1%) stress levels (P = 0.048). They also demonstrated markedly lower motivation for virtual class participation (60.7%) compared to students with low (16.7%) and moderate (34.9%) stress levels (P = 0.007). Furthermore, these highly stressed students reported significantly poorer time management in the virtual educational setting (35.7%) compared to their peers with low (5.6%) and moderate (9.5%) stress levels (P = 0.002). Conversely, students experiencing lower levels of academic stress exhibited more favorable behaviors, characterized by reduced food cravings and more positive perceptions of their virtual learning environment (Table 4).

Multiple regression analysis confirmed the independent associations observed in bivariate analyses. After adjusting for age, sex, BMI, and waist circumference, the consumption of processed foods and sweets among students with food cravings remained statistically significant (OR = 8.95, 95% CI: 2.124–37.781, P = 0.003), as did the association with red and fatty meats consumption (OR = 4.50, 95% CI: 1.084–23.029, P = 0.039) (Table 2). Students with negative virtual education experiences showed independently higher consumption of energy-dense, high–saturated fat foods (β = 1.82, 95% CI: 0.365–3.281, P = 0.015) after controlling for potential confounders. The association between negative virtual education experiences and high academic stress remained significant in the adjusted model (OR = 4.91, 95% CI: 1.735–13.869, P = 0.003) (Table 3). Finally, high academic stress remained significantly associated with increased food cravings (OR = 4.71, 95% CI: 1.192–18.578, P = 0.027) and consumption of foods high in complex carbohydrates and proteins (β = 3.76, 95% CI: 0.189–7.341, P = 0.040) (Table 4).

Discussion

This retrospective cross-sectional study investigated the relationship between dietary patterns, nutritional characteristics, academic stress, and virtual education among university students in Mexico during the COVID-19 lockdown period. This research utilized validated self-reported questionnaires to assess dietary patterns, nutritional intake, and academic stress levels, ensuring methodological rigor in data collection.[9–12] The findings revealed significant challenges faced by university students during the COVID-19 lockdown. Students experienced elevated academic stress while simultaneously struggling with disrupted eating patterns and difficulties adapting to the virtual educational environment. These observations align with existing literature documenting the pandemic's widespread impact on university student populations, particularly regarding academic stress and altered eating behav-

Table 4. Association of food craving and virtual educational environment with academic stress levels in university students during the COVID-19 lockdown

Variables	Academic stress levels			*P*-value	Adjusted β or OR (95% CI)	*P*-value
	Low	Moderate	High			
n = 108	18 (16.7%)	63 (58.3%)	27 (25.0%)			
Age (years)	22.3 ± 4.3	22.3 ± 3.9	21.4 ± 1	0.483	–	–
BMI (kg/m^2)	23 ± 2.9	23.3 ± 3.3	22.4 ± 4.3	0.587	–	–
BMI 18.5 - 24.9 kg/m^2, n (%)	15 (83.3%)	45 (71.4%)	22 (81.5%)	0.492	–	–
BMI ≥ 25.0 kg/m^2, n (%)	3 (16.7%)	18 (28.6%)	5 (18.5%)			
WC (cm)	74.4 ± 8.4	72.3 ± 8.9	73.8 ± 13.9	0.843	–	–
Food craving						
Food craving, n (%)	1 (5.6)	6 (9.7)	8 (29.6)	0.020*	OR:4.71 (1.192–18.578)	0.027
Towards foods high in simple sugars and trans fats	16.2 ± 7.7	18.2 ± 9.5	20.3 ± 9.7	0.327	β: 4.12 (−0.890–9.137)	0.107
Towards foods high in complex carbohydrates and proteins	13.7 ± 6.1	14.7 ± 6.2	17.5 ± 5.1	0.037*	β: 3.76 (0.189–7.341)	0.040
Towards foods high in calories and saturated fat	6.7 ± 3.6	7.1 ± 3.6	8.9 ± 3.5	0.055	β: 2.18 (−0.058–4.411)	0.057
Perception of the virtual educational scenario						
Overwhelmed by virtual school workload, n (%)	7 (38.9%)	36 (57.1%)	21 (75.0%)	0.048*	OR: 4.03 (1.309–12.377)	0.015
Poor recognition and no contact with peers, n (%)	6 (33.3%)	27 (42.9%)	14 (50.0%)	0.571	OR: 2.05 (0.775–5.402)	0.148
No motivation to join virtual classes, n (%)	3 (16.7%)	22 (34.9%)	17 (60.7%)	0.007*	OR: 3.46 (1.258–9.484)	0.016
Unsatisfactory experience with virtual education, n (%)	1 (5.6%)	12 (19.0%)	9 (32.1%)	0.091	OR: 2.87 (0.815–10.137)	0.101
Poor distribution of time in virtual education, n (%)	1 (5.6%)	6 (9.5%)	10 (35.7%)	0.002*	OR: 8.06 (2.226–29.198)	0.001

The values are presented as mean ± standard deviation unless otherwise reported as frequency (*n*) and percentage (%). *High vs. low & moderate. The one-way ANOVA, Kruskal-Wallis test, and Chi-Square test were the statistical methods. Fisher's exact test was used for all comparisons due to small expected cell frequencies (<10 cases). Adjusted analyses were obtained through multiple linear regression (β coefficients) or logistic regression (OR) models, which were adjusted for age, sex, BMI, and waist circumference. High academic stress level used as reference category for OR calculations. – indicates analysis not performed due to zero cases in one group. ANOVA, analysis of variance; BMI, body mass index; CI, confidence intervals; OR, odds ratio; WC, waist circumference.

iors. Previous studies have specifically highlighted the correlation between these challenges and an increased prevalence of adverse emotional states, including depression, anxiety, and insomnia, during the lockdown period.[15,16] These findings underscore the interconnected nature of academic stress, dietary habits, and adaptation to virtual learning environments.

The results demonstrate a significant association between elevated academic stress levels and increased food cravings among university students during the lockdown period. Students experiencing high academic stress exhibited a markedly higher frequency of food cravings (29.6%, $P = 0.020$), particularly toward high-calorie foods ($P = 0.037$). These observations are consistent with those previously documented in the scientific literature.[17] The observed increase in consumption of complex carbohydrates and proteins during this period can be attributed to multiple physiological and psychological mechanisms associated with academic stress during confinement. Research has established that stress triggers significant neurochemical responses, particularly the release of cortisol, which serves as a key mediator in appetite regulation. This hormonal response typically generates an increased preference for calorie-dense foods as part of the body's energy compensation mechanism. Furthermore, the preferential consumption of complex carbohydrates and proteins may serve an adaptive function, as these macronutrients have been shown to modulate stress responses through their role in serotonin synthesis, potentially contributing to temporary stress relief.[18]

Furthermore, university students experiencing elevated academic stress demonstrated significantly diminished perceptions of their virtual educational experience, characterized by increased feelings of being overwhelmed and lack of motivation compared to their counterparts with lower stress levels. These findings highlight the need to implement comprehensive psycho-nutritional support strategies to enhance academic stress management among university students. This necessity is particularly evident given the documented negative effects of the COVID-19 lockdown on the student population that persisted beyond the World Health Organization's declaration of the pandemic's end.[19]

Analysis of nutritional characteristics revealed that students experiencing high academic stress demonstrated significantly greater preferences for energy-dense, nutrient-poor foods, particularly red and fatty meats, sausages, and refined cereals, compared to their counterparts with lower stress levels. These dietary habits have a well-documented physiological basis: during periods of elevated stress, the ventral tegmental area's reward system releases substantial quantities of dopamine, a neurotransmitter integral to pleasure-seeking behaviors.[20] From a nutritional perspective, this physiological response manifests as increased consumption of highly palatable foods, especially those rich in fats and simple sugars. These foods function as potent stimulants of the reward system, triggering pleasure signals that induce temporary states of comfort and relaxation, thereby temporarily alleviating stress. Notably, nutrient-dense plant-based foods typically fail to activate these reward pathways as effectively, explaining their reduced consumption during periods of heightened stress.[21]

This stress-induced pattern of maladaptive eating behaviors carries significant health implications, potentially contributing to metabolic dysregulation through various mechanisms, including weight gain and disturbances in glucose and lipid homeostasis. Such metabolic alterations may accelerate the onset of chronic non-communicable diseases, including obesity, diabetes, and cardiovascular conditions, at earlier ages than typically observed.[22] Moreover, the intensified academic stress during the COVID-19 lockdown likely exacerbated these detrimental dietary habits, creating a self-perpetuating cycle of poor nutritional choices and deteriorating emotional and physical health among university students.[15]

Analysis revealed significant associations between negative virtual education experiences during lockdown and increased food cravings, particularly the consumption of energy-dense, high–saturated fat foods. These dietary habits correlated strongly with elevated academic stress levels, indicating that adaptation to remote learning presented substantial challenges for a considerable proportion of students. Prior research has documented that the transition to virtual education during the COVID-19 lockdown intensified both academic stress and dietary challenges among university students.[3,23] Students reporting negative experiences with the virtual educational environment demonstrated higher frequencies of maladaptive eating behaviors, including increased food cravings and preferential consumption of energy-dense, high–saturated fat foods. These students also exhibited significantly higher academic stress levels compared to peers who maintained positive perceptions of virtual learning. This behavioral pattern can be largely explained through the neurobiological mechanisms of the brain's reward system and its pursuit of positive reinforcement.[21] The scientific literature has established that foods high in fat and sugars possess significant addictive potential, activating neurobiological responses that contribute to the development and perpetuation of maladaptive eating patterns, particularly during periods of elevated stress.[24,25]

This study presents several inherent methodological limitations that warrant careful consideration. Primarily, the cross-sectional design precludes establishing causal relationships between elevated academic stress levels and maladaptive dietary habits during the COVID-19 confinement period. The study's recruitment from a single university institution potentially limits the generalizability of findings to the broader student population during the COVID-19 lockdown. The retrospective nature of the study introduces additional limitations, particularly regarding data collection methods. The reliance on self-reported questionnaires presents potential recall bias, as participants' ability to accurately recollect their nutritional habits and stress levels during the confinement period may be imperfect. Furthermore, the exclusive focus on data collection during the COVID-19 confinement period, without pre- or post-pandemic comparisons, prevents longitudinal analysis and limits the study's conclusive capacity. To address these limitations, future research should incorporate longitudinal study designs to establish temporal relationships; multi-institutional sampling to enhance population representativeness; objective data collection methods, including detailed dietary records; and biochemical measurements for precise assessment of nutritional status.

Future directions

The findings of this research establish a foundation for conducting new investigations with different approaches to advance understanding of the complex interrelationships between academic stress, dietary behaviors, and educational modalities in university populations. Future research should implement prospective cohort designs spanning multiple academic periods to establish temporal relationships between academic stress exposure and dietary behavior modifications. Additionally, studies involving multiple institutions with varied socioeconomic profiles, geographical locations, and educational structures would provide better insight into how institutional factors moderate the relationship between academic

stress and dietary behaviors.

For future investigations, it is advisable to incorporate biochemical stress markers, such as cortisol and other inflammatory markers, to complement self-reported stress assessments, which were not feasible in this study. Similarly, more objective dietary assessment methods, such as 24-h dietary recalls, would significantly improve the accuracy of dietary behavior evaluation. The development and validation of culturally adapted assessment instruments also represent priorities for this type of research. Tools for stress and dietary assessment must be specific to university populations, capturing the unique stressors and dietary patterns relevant to different contexts while maintaining psychometric rigor.

Finally, future research should evaluate the effectiveness and feasibility of interventions that integrate stress management, nutritional education, and academic support services, with the objective of structuring student wellness programs and identifying strategies for sustainable program delivery within university environments.

Conclusions

This retrospective investigation demonstrates the significant impact of the COVID-19 lockdown on academic performance, nutritional behaviors, and emotional well-being among university students in Mexico. The findings reveal an association between elevated academic stress levels and maladaptive dietary habits, characterized by an increased frequency of cravings for energy-dense foods. These dietary changes were notably concurrent with negative perceptions of the virtual education implemented during the lockdown period.

These results emphasize the critical need for implementing comprehensive support strategies addressing the holistic well-being of university students. Such interventions should focus on multiple domains: mitigating the adverse effects of academic stress, facilitating the adoption of health-promoting behaviors, and minimizing the negative impacts of COVID-19 lockdown measures and virtual education on the student population.

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Conflict of interest

The authors declare no conflicts of interest related to this publication.

Author contributions

Conceptualization (RTV, PGI), methodology (RTV, GCC, LRMG), software (LRMG), validation PGI, GCC), formal analysis (RTV, LRMG, EAZC), investigation (RTV, GCC, LRMG, PGI, DMF), resources (PGI, DMF), data curation (LRMG), writing - original draft preparation (RTV), writing - review and editing (RTV, EAZC, GCC, PGI, DMF), visualization (RTV, EAZC), project administration (PGI), and funding acquisition (DMF, PGI). All authors have made significant contributions to this study and have approved the final manuscript.

Ethical statement

This study was approved by the Local Committee for Health Research and Ethics 1801 of the Mexican Social Security Institute, based in the state of Nayarit, Mexico (Approval Number: R/2021/1801/017). All participants provided written informed consent prior to their inclusion in the study, following the principles established in the Declaration of Helsinki as revised in 2024.

Data sharing statement

The original data from this study are available upon request from the corresponding author, in compliance with confidentiality and participant privacy protocols.

References

[1] Al-Oraibi A, Fothergill L, Yildirim M, Knight H, Carlisle S, O'Connor M, *et al*. Exploring the Psychological Impacts of COVID-19 Social Restrictions on International University Students: A Qualitative Study. Int J Environ Res Public Health 2022;19(13):7631. doi:10.3390/ijerph19137631, PMID:35805287.

[2] Lalin SAA, Ahmed MNQ, Haq SMA. The effects of the COVID-19 pandemic on students' academic performance and mental health: An overview. Regional Science Policy & Practice 2024;16(7):100046. doi:10.1016/j.rspp.2024.

[3] Esteves Villanueva AR, Hañari Mormontoy JO, Ramos Turpo M, Incacutipa Limachi DJ. Estrés universitario en entorno virtual durante la COVID-19: Un problema de salud mental. Apunt Univ 2022;12(4):366–378. doi:10.17162/au.v12i4.1251.

[4] Castro I, Velazco Capistrán DL. Lo que dejo el covid-19 en la salud mental de los estudiantes. Ciencia Latina Revista Científica Multidisciplinar 2021;5(6):13778–13796. doi:10.37811/cl_rcm.v5i6.1357.

[5] Intelangelo L, Molina Gutiérrez N, Bevacqua N, Mendoza C, Guzmán-Guzmán IP, Jerez-Mayorga D. Efecto del confinamiento por COVID-19 sobre el estilo de vida en población universitaria de Argentina: Evaluación de la actividad física, alimentación y sueño (Effect of Confinement by COVID-19 on the Lifestyle of the University Population of Argentina: E). Retos 2021;43:274–282. doi:10.47197/retos.v43i0.88461.

[6] Coletro HN, Mendonça RD, Meireles AL, Machado-Coelho GLL, Menezes MC. Ultra-processed and fresh food consumption and symptoms of anxiety and depression during the COVID - 19 pandemic: COVID Inconfidentes. Clin Nutr ESPEN 2022;47:206–214. doi:10.1016/j.clnesp.2021.12.013, PMID:35063203.

[7] Dosil-Santamaria M, Ozamiz-Etxebarria N, Idoiaga Mondragon N, Reyes-Sosa H, Santabárbara J. Emotional State of Mexican University Students in the COVID-19 Pandemic. Int J Environ Res Public Health 2022;19(4):2155. doi:10.3390/ijerph19042155, PMID:35206340.

[8] Martínez Arriaga RJ, González Ramírez LP, de la Roca-Chiapas JM, Hernández-González M. Psychological distress of COVID-19 pandemic and associated psychosocial factors among Mexican students: An exploratory study. Psychol Sch 2021;58(9):1844–1857. doi:10.1002/pits.22570, PMID:34538936.

[9] Zepeda-Carrillo EA, Ramos-Lopez O, Martínez-López E, Barrón-Cabrera E, Bernal-Pérez JA, Velasco-González LE, *et al*. Effect of Met-

formin on Glycemic Control Regarding Carriers of the SLC22A1/OCT1 (rs628031) Polymorphism and Its Interactions with Dietary Micronutrients in Type 2 Diabetes. Diabetes Metab Syndr Obes 2022;15:1771–1784. doi:10.2147/DMSO.S354579, PMID:35711690.

[10] Marín-Soto MD, León CV, Pérez-Vielma NM, Castillo-Ramírez M, Miliar-García Á, Murillo-Tovar MM, *et al*. Intense craving for appetizing foods: validation and standardization of the Food Cravings Questionnaire-Trait in Mexico. Gac Med Mex 2020;156(1):27–33. doi:10.24875/GMM.19005358, PMID:32026878.

[11] Jáuregui Lobera I, Bolaños P, Carbonero R, Valero Blanco E. Psychometric properties of the Spanish version of Food Craving Inventory (FCI-SP). Nutr Hosp 2010;25(6):984–992. PMID:21519770.

[12] García-Ros R, Pérez-González F, Pérez-Blasco J, Natividad LA. Evaluación del estrés académico en estudiantes de nueva incorporación a la universidad. Revista Latinoamericana de Psicología 2012;44(2):143–154.

[13] World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013;310(20):2191–2194. doi:10.1001/jama.2013.281053, PMID:24141714.

[14] Keating XD, Zhou K, Liu X, Hodges M, Liu J, Guan J, *et al*. Reliability and Concurrent Validity of Global Physical Activity Questionnaire (GPAQ): A Systematic Review. Int J Environ Res Public Health 2019;16(21):4128. doi:10.3390/ijerph16214128, PMID:31717742.

[15] Monserrat-Hernández M, Checa-Olmos JC, Arjona-Garrido Á, López-Liria R, Rocamora-Pérez P. Academic Stress in University Students: The Role of Physical Exercise and Nutrition. Healthcare (Basel) 2023;11(17):2401. doi:10.3390/healthcare11172401, PMID:37685435.

[16] Haikalis M, Doucette H, Meisel MK, Birch K, Barnett NP. Changes in College Student Anxiety and Depression From Pre- to During-COVID-19: Perceived Stress, Academic Challenges, Loneliness, and Positive Perceptions. Emerg Adulthood 2022;10(2):534–545. doi:10.1177/21676968211058516, PMID:35382515.

[17] Arrascue J, Quispe A. Asociación entre los niveles de actividad física y los síntomas de depresión y ansiedad en estudiantes de Medicina Humana. Revista de Neuro-Psiquiatría 2023;86(2):90–101. doi:10.20453/rnp.v86i3.4559.

[18] Gonzalez MJ, Miranda-Massari JR. Diet and stress. Psychiatr Clin North Am 2014;37(4):579–589. doi:10.1016/j.psc.2014.08.004, PMID:25455067.

[19] Villanueva Javes JA. Depresión de los estudiantes universitarios durante la pandemia COVID-19: Revisión de literatura científica 2020 - 2022. Ciencia Latina Revista Científica Multidisciplinar 2023;6(6):13042–13059. doi:10.37811/cl_rcm.v6i6.4311.

[20] Berridge KC, Kringelbach ML. Pleasure systems in the brain. Neuron 2015;86(3):646–664. doi:10.1016/j.neuron.2015.02.018, PMID:25950633.

[21] Torres-Valadez R, Sandoval-Parra MG, Zepeda-Carrillo EA. Obesity and food addiction: Consumption of high-fructose corn syrup and the effectiveness of clinical-nutritional management. Clin Res 2020;1(1):01. doi:10.35702/clinres.10001.

[22] Vaamonde JG, Álvarez-Món MA. Obesidad y sobrepeso. Medicine 2020;13(14):767–776. doi:10.1016/j.med.2020.07.010.

[23] Celorio-Sardà R, Comas-Basté O, Latorre-Moratalla ML, Zerón-Rugerio MF, Urpi-Sarda M, Illán-Villanueva M, *et al*. Effect of COVID-19 Lockdown on Dietary Habits and Lifestyle of Food Science Students and Professionals from Spain. Nutrients 2021;13(5):1494. doi:10.3390/nu13051494, PMID:33924965.

[24] Coker CR, Keller BN, Arnold AC, Silberman Y. Impact of High Fat Diet and Ethanol Consumption on Neurocircuitry Regulating Emotional Processing and Metabolic Function. Front Behav Neurosci 2020;14:601111. doi:10.3389/fnbeh.2020.601111, PMID:33574742.

[25] Jacques A, Chaaya N, Beecher K, Ali SA, Belmer A, Bartlett S. The impact of sugar consumption on stress driven, emotional and addictive behaviors. Neurosci Biobehav Rev 2019;103:178–199. doi:10.1016/j.neubiorev.2019.05.021, PMID:31125634.