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RESEARCH ARTICLE

Association Between Nutrition Patterns and Metabolic and Psychological State Among Young Adults

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ABSTRACT

Background-Objectives: Obesity is an increasing global public health problem with severe correlated chronic diseases (physical and mental disorders). The aim of this study is to identify nutrient patterns among young adults who are overweight or obese based on their dietary intake, and to explore the associations between nutrient patterns and sociodemographic and clinical variables (anthropometric, cardiometabolic, and psychological).

Methods: A voluntary response (non-random) sample involving $N = 188$ overweight and obese university students (men and women, with a mean age of 20.8 years [SD = 2.6]) was recruited. Pregnancy, endocrine-genetic disorders, weight-loss diet and use of treatments that could affect endocrine parameters were defined as exclusion criteria.

Results: Three nutritional patterns were identified, that explained 69% of the total variance: (a) NP1, characterised by a high intake of minerals and vitamins; (b) NP2, characterised by a high intake of carbohydrates; and (c) NP3, characterised by a high intake of fats and sodium. Higher mean scores in NP1 were related to female gender ($p = 0.015$), while higher NP1 and NP2 levels were associated to divorced/separated marital status ($p = 0.007$ and $p = 0.041$, respectively). Path analysis revealed a direct relationship between being within metabolically unhealthy obesity (MUO) levels and higher levels of anxiety (standardised coefficient St.Coeff = 0.14, $p = 0.049$), depression (St.Coeff = 0.17, $p = 0.014$) and stress (St.Coeff = 0.13, $p = 0.048$). In addition, the metabolic risk profile (the classification into MUO vs. MHO) achieved a mediational link between the factor scores for NP1 and a worse psychological state.

Discussion: This study provides empirical knowledge to design more effective prevention and treatment plans for young adults who are overweight or obese, considering the impact nutritional patterns have on metabolic and psychopathological distress.

1 | Introduction

Being overweight or obese are major risk factors for several chronic health problems, and global growth over recent decades has had an impact on medical spending in healthcare systems (Pan American Health Organisation). Currently, around 2 billion people worldwide are overweight and obese, largely due to the negative impact of the obesogenic environments that encourage unhealthy diets and sedentary behaviour (Cumbre de Naciones Unidas sobre Sistemas Alimentarios, 2023). A report from the World Obesity Federation warns that, if effective public prevention and intervention policies supported by empirical evidence are not implemented, over the next few years more than half of the world's population will suffer from

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Summary

- Three nutritional patterns were identified among young adults with overweight and obesity based on their dietary intake (frequency and amount of food consumption in the last 12 months).
- The empirical nutritional patterns achieved capacity for discriminating the presence of metabolically unhealthy obesity (MUO).
- The empirical nutritional patterns achieved an indirect effect on the psychological distress, through the mediational link of the cardiometabolic problems associated to the overweight and obesity.

malnutrition due to excess, characterised by the consumption of low-cost, low-quality calories from ultra-processed foods and the intake of sugary drinks/soft drinks (World Obesity Federation marzo de 2023).

Being overweight or obese can occur throughout the lifespan, but highly vulnerable groups have been identified, such as university students. Admission to university is a period of great transformation and challenges, including assimilation into new groups of classmates, moving away from the family and adjusting to higher academic expectations. All these changes are powerful risk factors for the onset and progression of unhealthy habits, including eating behaviour. Previous studies have shown that a high proportion of young people from their first year at university exhibit poor nutrition (Almoraie et al. 2024): low dietary variety, low fruit and vegetable intake, frequent eating of highly processed and calorie-rich foods, drinking of sweetened beverages, skipping breakfast, eating out frequently and emotional eating. Consequently, the prevalence of overweight/obese students has been estimated at between 20% and 40% of all university students (Obirikorang et al. 2024; Guapi-Guamán et al. 2022). In addition, overweight/obese university students who exhibit unhealthy eating patterns and inflexible diets have reported a negative impact on their overall health during adulthood, including anthropometric issues (Yamamoto et al. 2021; Zamil and Amin 2022; Piché et al. 2020), physical diseases (such as increased risk of cardiovascular disease, breathing problems, joint problems such as osteoarthritis and musculoskeletal discomfort, gallstones and gallbladder disease) (Flores-Brito et al. 2023; Enriquez and Ader 2023; Sharda et al. 2023; Çakmak and Tanrıöver 2024; Mehta et al. 2023), psychological problems (depression, anxiety, and substance abuse) (Volpp et al. 2023; Bourdier et al. 2020; Choi 2020), and social problems (feelings of rejection and shame, and bullying). All these problems impacted both genders, although women demonstrated higher vulnerability (Kataoka et al. 2024).

Being overweight or obese are complex conditions with a multifactorial aetiology, involving genetic, endocrine/hormonal, psychological and environmental/contextual elements (Lin and Li 2021). In addition, excess weight impacts overall health through a complex dynamic network also involving multiple variables, such as the anatomical and metabolic effects of adipose tissue, genetics, lifestyle and psychosocial factors (Dakanalis et al. 2023). It is common to classify obese subjects into two categories according to their metabolic state: *metabolically healthy obesity* (MHO) versus *metabolically unhealthy obesity* (MUO) (Gómez-Zorita et al. 2021; Agius et al. 2024). The first category groups together people with excessive fat accumulation but no adverse metabolic effects (no dyslipidemia, hypertension, or insulin resistance, less visceral and hepatic fat, and greater respiratory and physical capacity). In contrast, the MUO endophenotype is characterised by metabolically unhealthy obesity, which includes metabolic syndrome (S. Blüher and Schwarz 2014). MUO has also been linked to increased comorbidity with anxiety disorders (J. Wang et al. 2022), stress (Jakubiak et al. 2021) and depression (Z. Wang et al. 2022), as well as to increased risk of disability, incapacitation and death (Karra et al. 2022; Mathis et al. 2023). It must be considered that the MHO endophenotype can be a transient state, and over time these subjects can progress to the MUO category (Telle-Hansen et al. 2020; Song et al. 2022).

The study of the etiopathogenesis of MUO has identified different risk factors, such as gender (higher risk for women) (Mendonça et al. 2024), high intake of carbohydrates-fats-sodium (J. Zhang et al. 2024), low physical activity (Taherifard et al. 2024) and higher levels of body mass index (BMI) (Vera-Ponce et al. 2024). It has also been observed that mental health problems also have an indirect impact on the risk of MUO, with dietary patterns being the mediating factors within the pathways (M. Blüher 2020; Tsatsoulis and Paschou 2020 jun; Tanriover et al. 2023 may). First, anxiety levels have been linked to the consumption of carbohydrates (Hu et al. 2022), fats (Li et al. 2020) and sodium (Farhadnejad et al. 2019), and these dietary habits have been connected to an increased likelihood of MUO (Ebrahimpour-Koujan et al. 2019). Second, high levels of stress and chronic depression may contribute to a lower level of physical activity (Szmodis et al. 2022), which acts as a trigger of MUO in obese subjects.

One of the difficulties in studying the impact of nutritional patterns is the measurement of this construct. A recent study conducted among overweight/obese adolescents identified three nutrient dietary patterns (Rouhani et al. 2023): (a) high in minerals and vitamins; (b) high in carbohydrates; and (c) high in fat and sodium. A diet closer to the pattern characterised by high fat and sodium was associated with a higher risk of metabolic problems, especially among men. To the best of our knowledge, few studies have researched the relationship between these nutritional patterns and anthropometric, metabolic and psychological health status in university students who are overweight/obese. Most studies in this area were aimed at identifying the association between the consumption of certain foods and specific metabolic complications (Y. Zhang et al. 2023; Bede et al. 2020; Pasdar et al. 2020), and mixed results were obtained (Saltzgiver et al. 2019; Mousavi et al. 2022). Therefore, new empirical evidence focused on the analysis of nutritional patterns among young adults who are overweight/obese is necessary, since this approach can provide results that will be easier to interpret than the specific analysis of certain foods.

The objectives of this study were: (a) to identify empirical nutritional patterns based on dietary intake; (b) to explore the associations between empirical nutritional patterns and sociodemographic, anthropometric, cardiometabolic and psychological profiles; and (c) to examine the mediational link of MUO in

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the relationship between empirical nutritional patterns and the psychological state (anxiety, depression and stress levels).

2 | Materials and Methods

2.1 | Participants

The participants were $n = 188$ overweight and obese students from the Catholic University of Cuenca (city of Azogues, Ecuador). All participants voluntarily agreed to participate, and provided a signed informed consent form. Exclusion criteria were being pregnant, the presence of endocrine or genetic disorders (hypothyroidism, type 1 diabetes mellitus, and Cushing's syndrome), being on a weight-loss diet, taking mineral and vitamin supplements, or other medications that could affect blood glucose, lipid profile, body weight, or blood pressure.

In this study the presence of eating behaviour related problems was not considered an exclusion criterion, since the aim of the study was to obtain empirical evidence from the young general population characterised by beingoverweight or obese. Since this target population includes individuals with and without problematic eating (e.g., the presence of bulimic behaviour is highly prevalent among individuals with a high BMI), their inclusion increases the external validity and the capacity to generalise the results to a more realistic general population.

2.2 | Measures

2.2.1 | Intake Pattern

The *Food Consumption Food Frequency* questionnaire (FCFF) (Morejón et al. 2021) was employed to register dietary intake. A trained nutritionist instructed the participants on the use of the tool and asked them to register the frequency of food consumption (daily, weekly and monthly) and the amount of food consumed in the last 12 months (based on common standard portion sizes). The total energy and nutrient intake was calculated by adding up the energy and nutrients from all foods. *Nutrimind* software (Nutrimind) was used for the management of data on nutrient intake.

2.2.2 | Anthropometry and Cardiometabolic Factors

The assessment of anthropometric indices and cardiometabolic risk factors was carried out by a trained nurse, with long experience in the area of nutrition. Weight was measured with a calibrated electronic scale (BCS-G6) (nearest 0.1 kg). Standing height was recorded with a stadiometer (nearest 0.1 cm). Waist circumference (WC) was measured twice for each participant and the mean value of the two assessments was considered WC (Bauce and Moya-Sifontes 2020). In this study, BMI was considered the main measurement of nutritional status, calculated by dividing weight in kilogrammes by height in metres squared. The BMI was divided into two levels according to the WHO (WHO. Ginebra: OMS): overweight ($25 \leq BMI < 30$) and obesity ($BMI \geq 30$).

After a 5-min rest, diastolic blood pressure (DBP) and systolic blood pressure (SBP) were recorded twice with a 15-min recovery interval, on the right arm (Gómez-León Mandujano et al. 2016). The average of the two measurements was analysed in the study.

Biochemical values were obtained through venous blood samples in a sitting position, after a twelve-hour fast. Blood glucose concentration, lipid profile and insulin concentrations were determined. Insulin resistance was defined using the Homoeostasis Model Assessment Insulin Resistance (HOMA-IR = [insulin (μIU/mL) × glucose (mg/dL)]/405) (Gordon et al. 2009).

Two methods were combined and applied for the classification of the participants' metabolic health status into MUO versus MHO. First, the modified criteria defined by the International Diabetes Federation (Barrea et al. 2021), that groups within the MUO condition individuals with at least two of the following cardio metabolic risk factors: increased triglycerides (≥ 150 mg/dL), elevated fasting blood glucose (≥ 126 mg/dL), decreased HDL-c (< 45 mg/dL), and elevated blood pressure (≥ 120/80 mmHg); according to this classification scheme, participants with one or no risk factors were grouped within the MHO condition. The second classification method was based on the insulin resistance index, which groups into the MUO level individuals with HOMA-IR ≥ 3 (this cut-off value is selected according to previous studies carried out with university study samples (Garmendia et al. 2009; Buccini and Wolfthal 2008; Nieto et al. 2020); this classification scheme includes MHO group participants with HOMA-IR < 3.

2.2.3 | Psychological Profile

The *Depression, Anxiety and Stress Scale* (DASS-21) (Román et al. 2016) was used for the assessment of the psychological state. This is a 21-item self-report questionnaire, registered with a Likert scale with a range from 0 = 'never' to 3 = 'almost always'. The scale was developed to measure symptoms related to depression, anxiety and stress over the last week. A total score is also provided as a measure of overall psychological distress. For this study, internal consistency was between good to excellent: $\alpha = 0.80$ for depression, $\alpha = 0.82$ for anxiety, $\alpha = 0.86$ for stress, and $\alpha = 0.90$ for the total scale.

2.2.4 | Physical Activity Level

The *International Physical Activity Questionnaire* (IPAQ) (Palma-Leal et al. 2022) was employed to measure physical activity. This is a standardised self-report widely used among individuals between 15 and 69 years old. This tool provides an indirect measure of habitual physical activity (moderate to vigorous) and inactivity (time spent sitting) in the last week. Items evaluate the frequency and duration of walking, daily activities and time spent sitting. The IPAQ covers four key components of physical activity: domestic and gardening (yard) activities, work, transportation, leisure-related activities.

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2.2.5 | Socioeconomic Variables

In addition to nutritional and other variables, the participants' age, sex, social position index and marital status were registered.

2.3 | Procedure

The recruitment of the participants was undertaken after obtaining authorisation from the Rector's Office, as well as the program/s supervisors and lecturers. An invitation letter, sent from the institutional email address, was sent out to students.

The subjects who agreed to participate were scheduled for two assessment sessions. The first session was carried out in the classroom. Two clinical psychologists and one nutritionist trained in the use of psychometric assessment tools requested that participants fill in the questionnaires used for measuring the nutritional, psychological and sociodemographic data. This session had a duration of approximately 40 min.

After completing the first session, each student was provided with information about the date and time of the second session. During this second session, a nurse and a clinical psychologist (both with more than 10 years of experience in this field) recorded the anthropometric and chemical data.

All the data was collected during October 2023. Participation was voluntary and no financial or academic rewards were obtained.

2.4 | Statistical Analysis

The statistical analysis was performed using STATA.18 for Windows. For the first objective, factor analysis with orthogonal transformation (the Varimax procedure) was applied to explore nutrient patterns based on the 34 nutrients and bioactive compounds measured in the study. Factors were retained for further analysis based on their natural interpretation, eigenvalues, and scree plot (Rouhani et al. 2023). For this study, factors/dimensions with eigenvalues > 2 were retained, and interpreted as nutritional patterns. The factor scores for each nutritional pattern were obtained by adding together the total grams of all nutrients weighted by their factor loadings. The nutritional patterns were labelled according to the group of components with high loadings into the pattern/dimension. The Kaiser-Meyer-Olkin test (KMO) was used to assess whether the data was suitable for factor analysis. This coefficient is commonly used for measuring sampling adequacy, based on the estimation of the proportion of variance in the variables that might be explained by underlying factors. For this study, values KMO > 0.70 are interpreted as acceptable.

The following objectives were contrasted with different statistical procedures. First, the comparison of the mean between groups was carried out using a *t*-test and one-way analysis of variance (ANOVA). Second, the association between the variables was undertaken using Pearsons' correlation model. Due to the strong association between this procedure and the sample size (low correlation values tend to achieve significant results in large samples, while high correlation values tend to achieve non-significant results in small samples), relevant correlations were considered for coefficients $|R|$ within the range of mild-moderate to large-high (Taylor 1990).

Finally, a path analysis measured the direct and indirect links between the factor scores in the nutritional patterns with MUO and psychological distress. This study implemented path analysis through structural equation modelling (SEM), using the maximum likelihood estimation procedure (Kline 2005). The justification of the path diagram (model specification) was based in the theoretical background provided by the accumulated empirical evidence (as summarised in the introduction section), within the constraints of available measurement tools/data, adequate fit, and ensuring the clinical significance of the retained final model (Bentler 1990). All parameters in the SEM were freely estimated, and in order to obtain a more parsimonious model and increase statistical power, parameters without significant tests were removed and the model was respecified and refitted (Barrett 2007). Adequate fit was assessed using the usual indices (Bielby and Hauser 1977): χ 2 test, root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis index (TLI) and standardised root mean square residual (SRMR). Adequate fit was considered for non-significant results in the χ 2 test ($p > 0.05$), RMSEA < 0.09, CFI > 0.90, TLI > 0.90 and SRMR < 0.10. The overall predictive capacity of the model was measured using the coefficient of determination (CD).

3 | Results

3.1 | Factor Analysis to Identify Nutritional Patterns

The KMO coefficient obtained from this study indicates sampling adequacy (KMO = 0.84). The solution selected for this study retained 3 nutritional patterns, that explained 69.1% of the total variance in the dietary intake measured using FCFF (see Table 1). The factors were labelled as: (a) NP1 'high content of minerals and vitamins' (38.0% explained variance), characterised by a high intake of potassium, magnesium, folate, pantothenic acid, riboflavin, phosphorus, zinc, calcium, vitamin B12, B6 and C, and fibre; (b) NP2 'high carbohydrate' (21.1% explained variance), characterised by a high intake of thiamine, niacin, carbohydrates and iron; and (c) NP3 'high fat and sodium' (10.0% explained variance) characterised by a high intake of polyunsaturated fatty acids, sodium, saturated fatty acids and monounsaturated fatty acids.

3.2 | Association Between Nutritional Patterns and the Other Variables Analysed in the Study

Table 2 displays the results of analysing the association between the factor scores in the nutritional patterns (NP1, NP2 and NP3) and sociodemographic profile, university studies and physical activity levels. It is observed that compared to men, women have a higher average score in the nutritional pattern characterised

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TABLE 1 | Factor loadings obtained in the factorial analysis.

	NP1	NP2	NP3
Vitamin B1 (mg/day)		0.888	
Vitamin B2 (mg/day)	0.937		
Vitamin B6 (mg/day)	0.910		
Vitamin B12 (mg/day)	0.761	0.430	
Vitamin E (mg/day)			0.789
Total fibre (g/day)	0.904	0.753	
Biotin (mcg/day)	0.772	0.541	
PUFA (g/day)	0.401	0.407	0.483
Potassium (mg/day)	0.730	0.623	0.400
Folate (mcg/day)	0.919	0.678	
Niacin (mg/day)		0.680	0.610
TFAs (g/day)	0.231		0.372
Pantothenic acid (mg/day)	0.657		0.540
Vitamin C (mg/day)	0.649	0.442	
SFA (g/day)	0.267		0.328
Protein (g/day)	0.832	0.801	0.322
Zinc (mg/day)	0.465	0.401	0.321
MUFA		0.612	0.619
Manganese (mg/day)	0.387		0.201
Selenium (mg/day)		0.332	0.241
Cholesterol (mg/day)	0.653	0.764	
Iron (mg/day)		0.314	0.278
Sodium (mg/day)			0.859
Sugar (g/day)	0.401	0.281	
Carbohydrate (g/day)		0.613	0.329
Vitamin A (RE/day)	0.873	0.621	
Calcium (mg/day)	0.788		0.327
Magnesium (mg/day)	0.795		0.349
Vitamin D (mcg/day)	0.432	0.413	
Phosphorus (mg/day)	0.636		0.427
Variance explained (%)	38.04	21.11	9.97
Cumulative explained variance (%)	38.04	59.15	69.12

Note: Factor loadings < |0.20| are not shown for simplicity. Results obtained in factor analysis with orthogonal transformation (Varimax method).
Abbreviations: MUFA, Mono-unsaturated-fatty-acid; NP1: minerals and vitamins; NP2: carbohydrates; NP3: Fat and sodium; PUFA, Poly unsaturated fatty acids; SFA, Saturated fatty acids; TFAs, Trans fatty acids.

by the consumption of minerals and vitamins ($p = 0.015$). Widowers have the lowest average scores in mineral and vitamin consumption ($p = 0.007$) and in carbohydrate consumption ($p = 0.041$). In addition, students enroled on engineering and social science degrees have the highest scores in mineral and vitamin consumption ($p = 0.033$); and students who study health and well-being obtained the lowest average score in the pattern of fat and sodium consumption ($p < 0.001$). No association was identified between the factor scores in the nutritional patterns and socioeconomic status or physical activity level groups.

Table 3 displays the correlation matrix for the associations between the factor scores in the nutritional patterns with the anthropometric, cardiometabolic and psychological variables, as well as with dietary intake. Higher scores in the nutritional pattern NP1 were positively related with most dietary measures ($|R| > 0.24$, into the range mild-moderate to large-high), except for carbohydrates, fat, and monounsaturated and polyunsaturated fatty acids. The factor scores for NP2 were positively associated with energy ($R = 0.47$) and folate consumption ($R = 0.24$), and negatively associated with calcium intake ($R = -0.29$). And the scores for NP3 were positively related with energy intake ($R = 0.37$), fat ($R = 0.86$), saturated fatty acids ($R = 0.70$), monounsaturated and polyunsaturated fatty acids ($R = 0.90$), folate ($R = 0.39$), total fibre ($R = 0.47$) and sodium ($R = 0.27$); NP3 was also negatively related with carbohydrates ($R = -0.24$).

The upper part of Table 4 contains the comparison of the factor scores for the nutritional patterns in participants within the groups MHO versus MUO (see also the radar charts displayed in Figure 1, upper panel). Based on the HOMA-IR classification, MUO was associated with a lower mean score for NP1 (minerals and vitamins, $p = 0.040$).

The lower part of Table 4 shows the comparison of the psychopathological distress in participants in the MHO group versus the MUO group, according to the HOMA-IR and IDF criteria (see also the radar charts displayed in Figure 1, lower panel). Based on the HOMA-IR classification, MUO was associated with higher depression symptom levels ($p = 0.018$); considering the IDF classification, MUO was related with a worse psychological state (higher levels of anxiety, depression and stress; $p < 0.001$ for the three tests).

Figure 2 displays the path diagram with the standardised coefficients of the path analysis obtained in the study. Regarding nutritional patterns, only NP1 was retained in this final model, since NP2 and NP3 did not achieve relationships with obesity classification (MUO vs. MHO) or psychological state. This final model obtained adequate fit: $\chi^2 = 2.14$ ($p = 0.544$), RMSEA = 0.001, CFI = 0.999, TLI = 0.999, and SRMR = 0.014. Table 5 shows the full results of the SEM.

A direct link was identified between being within the MUO group and higher levels of anxiety (standardised coefficient St. Coeff = 0.14, $p = 0.0.049$), depression (St.Coeff = 0.17, $p = 0.014$) and stress (St.Coeff = 0.13, $p = 0.048$). In addition, an indirect impact of NP1 on psychological state was also observed, through the next pathways: lower factor scores for NP1 increased the likelihood of MUO (St.Coeff = −0.15, $p = 0.035$), and this highly metabolic risk profile is next associated with a worse psychological state.

4 | Discussion

This study identified nutrient patterns among young adults who are overweight/obese based on their dietary intake and explored the associations between nutrient patterns and sociodemographic/clinical profiles (anthropometric, cardiometabolic, and

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TABLE 2 | Association between the factor scores in the nutritional patterns with the sociodemographic variables, the university studies, and the physical activity levels.

		NP1			NP2			NP3		
	n	***Mean***	**SD**	***p***	***Mean***	**SD**	***p***	***Mean***	**SD**	***p***
Sex										
Women	81	66,685.1	1813.7	**0.015**[a]	269.0	46.3	0.531	75.6	16.8	0.347
Men	107	7355.3	1892.2		273.2	45.0		78.2	19.5	
Civil status										
Single	148	7023.0	1877.9	**0.007**[a]	267.7	42.9	**0.041**[a]	77.5	19.2	0.795
Married/couple	35	6938.9	1710.9		285.9	53.3		74.7	15.7	
Divorced/Separated	4	10,182.1	1057.4		296.7	30.8		81.5	8.5	
Windower	1	5514.9	—		201.5	—		70.8	—	
Socioeconomic status										
High	71	7276.1	2176.5	0.447	277.1	39.3	0.348	77.5	15.8	0.277
Medium	62	7121.9	1873.0		272.9	44.2		74.2	18.8	
Low	55	6855.9	1638.3		265.5	50.6		79.2	19.7	
University career										
Health and wellness	90	6894.5	2009.7	**0.033**[a]	278.0	48.4	0.067	71.3	16.4	**< 0.001**[a]
Engineering	16	7772.3	1428.8		267.1	36.6		83.1	15.8	
Business Administration	10	6292.2	1032.8		272.1	33.3		84.1	19.3	
Humanities education	41	6796.1	1453.1		253.8	49.7		84.3	24.2	
Social sciences	31	7809.4	2179.7		277.3	32.0		78.8	8.6	
Physical activity levels										
Sedentary	164	7062.2	1860.1	0.934	270.1	45.1	0.334	77.2	18.9	0.744
Low-activity	24	7096.2	2078.8		279.8	47.8		75.9	14.1	

Note: Results obtained with *t*-test (for the comparison between sexes) and ANOVA (for the remaining variables).
Abbreviations: NP1, minerals and vitamins; NP2, carbohydrates; NP3, Fat and sodium; SD, standard deviation.
[a]Bold: significant association/comparison.

psychological measures). Our results suggested three first-order nutritional patterns, characterised by a ahigh intake of minerals and vitamins (NP1), a high intake of carbohydrates (NP2), and a high intake of fats and sodium (NP3). Path analysis revealed direct links between MUO and increased anxiety, depression and stress. In addition, MUO was a mediational link between NP1 and psychological distress.

The nutrition patterns identified in this study as a function of dietary intake are consistent with the results reported by Rouhani et al. among a sample of young participants (children and adolescents) (Rouhani et al. 2023). The main difference: the rotated factor matrix in our study did not retain vitamin B3, chromium, fluoride, vitamin K or copper. The exclusion of these items could be the result of age-related dietary differences and cultural trends involving the consumption of certain foods (PUCE 2022).

A previous study also determined four nutrient patterns among individuals who are overweight (Teymoori et al. 2021): carbo-vitamins (thiamine, iron, carbohydrates, zinc, niacin, proteins, magnesium, phosphorus, riboflavin), lipids (PUFAs, MUFA, vitamin E, trans fatty acids), antioxidants (beta-carotene, vitamin K, vitamin A, vitamin C) and dairy (vitamin D, calcium). The factors labelled as lipids and antioxidants showed an internal composition similar to NP3 (high in fat and sodium nutrients) in our results, which probably indicates that the quality of the dietary intake in people who are obese/overweight would explain the high risk of metabolic diseases. This observation is also consistent with prior research, that shows that although there areclear differences in classic predominant eating patterns in each country, the structure of diets has been shifting away from the traditional composition toward high-fat, low-carbohydrate and low-fibre diets, with severe consequences on people's health (R. Zhang et al. 2015; Bojorquez et al. 2015).

Regarding the association between nutritional patterns and the sociodemographic profile, university studies and levels of physical activity, our analyses reinforce previous studies, and indicate that, compared to men, women achieve higher scores in the consumption of the nutritional pattern characterised by minerals and vitamins (Karamati et al. 2024). This evidence can be explained by biological factors that contribute to the need for higher intake of these nutrients among the female gender, for example menstruation (which increases the need for iron), and pregnancy and lactation (which lead to an increased need for folic acid, calcium and iron) (Simpson et al. 2011). Furthermore, studies have reported that women have a higher proportion of

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TABLE 3 | Association between the factor scores in the nutritional patterns with the anthropometric, cardiometabolic, psychological and dietary intake.

	NP1	NP2	NP3
Anthropometric variables			
Weight (kg)	0.16	0.03	0.01
Height (m^2)	0.14	−0.04	0.09
BMI (kg/m^2)	0.10	0.09	−0.08
Waist circumference (cm)	0.10	0.07	−0.11
Cardiometabolic variables			
Systolic blood pressure (mmHg)	0.03	0.14	−0.00
Diastolic blood pressure (mmHg)	−0.04	0.13	0.00
Fasting blood glucose level (mg/dL)	−0.07	0.07	−0.09
Insulin (μUI/mL)	−0.16	−0.10	0.00
HOMA-IR index	−0.16	−0.07	−0.04
Triglycerides (mg/dL)	0.05	0.02	0.03
HDL cholesterol (mg/dL)	−0.17	−0.10	0.00
Psychological variables			
Anxiety	−0.06	0.02	−0.14
Depression	0.00	0.07	−0.14
Stress	0.00	0.15	−0.23
Dietary intake			
Energy, kcal	**0.27**[a]	**0.47**[a]	**0.37**[a]
Protein, % of E	**0.46**[a]	−0.21	−0.12
Carbohydrate, % of E	0.02	0.97	**−0.24**[a]
Fat, % of E	0.06	−0.16	**0.86**[a]
SFA, gr	**0.34**[a]	−0.13	**0.70**[a]
MUFA, gr	0.18	−0.21	**0.90**[a]
PUFA, gr	0.01	0.02	**0.34**[a]
Vitamin C, mg	**0.77**[a]	0.20	0.07
Vitamin B6, mg	**0.53**[a]	−0.09	−0.18
Vitamin E, mg	**0.40**[a]	−0.21	0.06
Folate, mcg	**0.64**[a]	**0.24**[a]	**0.39**[a]
Iron, mg	**0.56**[a]	0.21	0.21
Calcium, mg	**0.48**[a]	**−0.29**[a]	0.05
Total fibre, gr	**0.75**[a]	0.22	**0.47**[a]
Sodium, mg	**0.50**[a]	0.09	**0.27**[a]

Note: Results correspond to Pearson's correlation coefficients.
Abbreviations: E, energy intake; MUFA, monounsaturated fatty acids; NP1, minerals and vitamins; NP2, carbohydrates; NP3, Fat and sodium; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids.
[a]Bold: effect size within the range mild-moderate to large-high.

body fat, which affects the need for fat-soluble vitamins (such as vitamins A, D, E, and K) (Stevens 2021). And these factors are related to physiological differences and female life stages, thus supporting the results of this study.

Another interesting result of this study is the association between marital status and the factor scores for the nutrition patterns. Divorced/separated and widowed subjects achieved a lower consumption of minerals and vitamins, and widowed subjects also a reported lower intake of carbohydrates. Previous evidence also observed a reduced consumption of vitamins and minerals among divorced/separated and widowed people and concluded that these dietary patterns could be explained by a combination of emotional, social, economic and health factors (Yannakoulia et al. 2008; Haapala et al. 2012). The reduced consumption of carbohydrates among widowed people is also consistent with prior studies (Rosenbloom and Whittington 1993), which concluded that emotional and social factors

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TABLE 4 | Association between the metabolic health state with the nutritional patterns and the psychological distress.

	HOMA-IR criterion					IDF criterion				
	MHO; $n = 132$		MUO; $n = 56$			MHO; $n = 61$		MUO; $n = 127$		
	Mean	SD	Mean	SD	p	Mean	SD	Mean	SD	p
NP1	7249.9	1905.8	6634.5	1772.1	**0.040**[a]	7015.2	1740.6	7091.2	1954.6	0.797
NP2	271.8	45.2	270.3	46.4	0.831	268.7	43.5	272.7	46.5	0.576
NP3	76.6	18.5	78.1	18.2	0.628	80.6	19.9	75.3	17.4	0.064
Anxiety	5.08	1.54	5.54	1.54	0.062	4.57	1.30	5.52	1.57	**< 0.001**[a]
Depression	5.74	1.27	6.23	1.31	**0.018**[a]	5.34	0.66	6.15	1.44	**< 0.001**[a]
Stress	10.46	2.60	11.23	2.61	0.065	9.15	2.09	11.43	2.53	**< 0.001**[a]

Note: Results obtained with *t*-test procedures.
Abbreviations: HOMA-IR, Homoeostasis Model Assessment Insulin Resistance; IDF, International Diabetes Federation; MHO, Metabolically healthy obese; MUO, Metabolically unhealthy obese; NP1, minerals and vitamins; NP2, carbohydrates; NP3, Fat and sodium; SD, standard deviation.
[a]Bold: significant association/comparison.

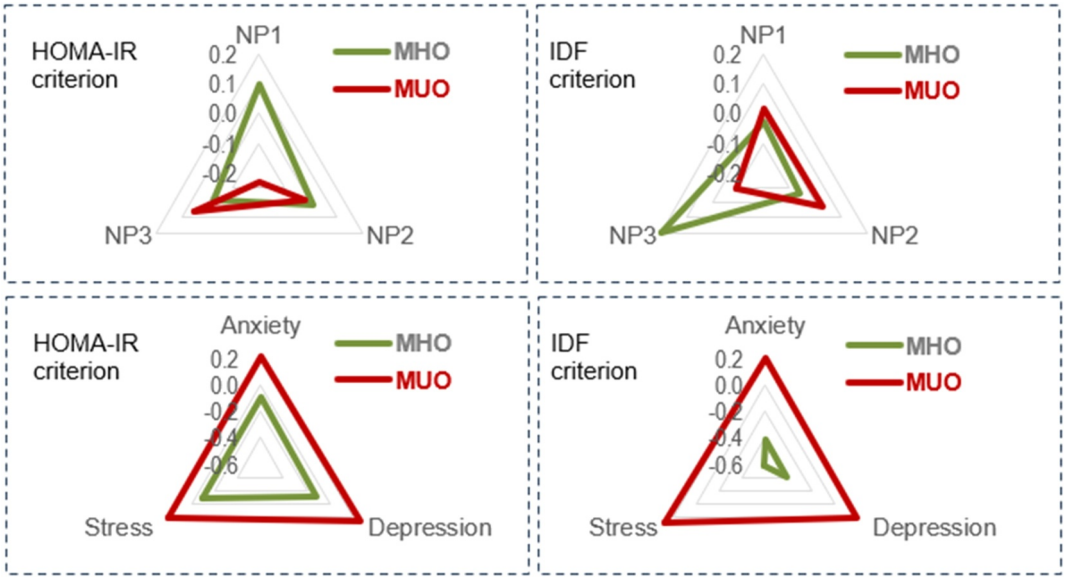


FIGURE 1 | Radar charts. Standardised mean values are plotted. HOMA-IR, homoeostasis model assessment insulin resistance; IDF, International Diabetes Federation; MHO, metabolically healthy obese; MUO, metabolically unhealthy obese; NP1, minerals and vitamins; NP2, carbohydrates; NP3, fat and sodium.

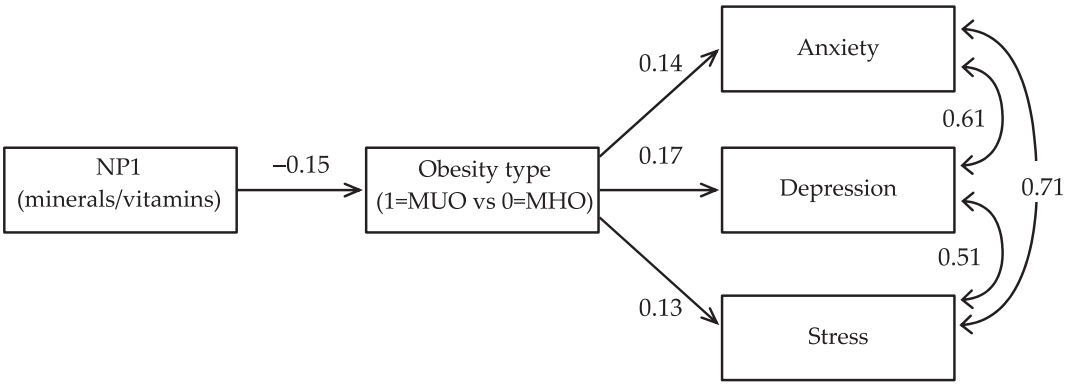


FIGURE 2 | Path diagram with the standardised coefficients. Standardised coefficients of the final path analysis model (implemented through SEM with maximum likelihood estimation). HOMA-IR, Homoeostasis Model Assessment Insulin Resistance; IDF, International Diabetes Federation; MHO, Metabolically healthy obese; MUO, Metabolically unhealthy obese; NP1, minerals and vitamins; NP2, carbohydrates; NP3, Fat and sodium.

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TABLE 5 | Complete results obtained in the SEM.

		St.Coeff	SE	*z*	*p*	95% CI	St.Coeff.
Obesity type	NP1	−0.1498	0.0709	−2.11	0.035	−0.2888	−0.0109
Stress	Obesity type	0.1347	0.0716	1.98	0.048	0.0056	0.2751
Depression	Obesity type	0.1731	0.0707	2.45	0.014	0.0345	0.3118
Anxiety	Obesity type	0.1363	0.0716	1.97	0.049	0.0039	0.2766
Covariances	Stress/Depression	0.5121	0.0538	9.52	< 0.001	0.4067	0.6176
	Stress/Anxiety	0.7142	0.0357	19.98	< 0.001	0.6441	0.7842
	Depression/Anxiety	0.6080	0.0460	13.23	< 0.001	0.5179	0.6981
	Goodness-of-fit	**Fitted**	**Var.**	**Residual**	***R*-squared**	**mc**	**mc^2**
Equation-level	Obesity type	0.2091	0.0047	0.2045	0.0224	0.1498	0.0224
	Stress	6.8304	0.1240	6.7063	0.0182	0.1347	0.0182
	Depression	1.6737	0.0502	1.6235	0.0300	0.1731	0.0300
	Anxiety	2.3803	0.0442	2.3360	0.0186	0.1363	0.0186

Note: NP1: minerals and vitamins. Obesity type (1 = MUO vs. 0 = MHO, based on the HOMA-IR index). Results of the final path analysis model (implemented through SEM with maximum likelihood estimation).
Abbreviations: 95% CI, 95% confidence interval; mc, correlation between dependent variable and its prediction; mc^2, Bentler–Raykov squared multiple correlation coefficient; MHO, Metabolically healthy obese; MUO, Metabolically unhealthy obese; SE, standard error; St.Coeff, standardised coefficient.

(such as the loss of a loved one) could cause stress and depression, which affects appetite and the motivation to prepare full meals. Widowed individuals typically change their eating routine and tend to eat alone, which can result in less elaborate and balanced meals (food rich in carbohydrates is reduced in their diets). These nutrition patterns that are characteristics of non-married people can contribute to decreased general health among this population.

Our analysis indicates that engineering and social sciences students have a high consumption of minerals and vitamins; and students studying health and well-being have a high consumption of fats and sodium. These results could be caused by the fact that engineering students tend to consume more foods that are rich in minerals and vitamins to support their concentration and energy for their demanding studies (Griban et al. 2021). In contrast, health students, despite their knowledge of nutrition, tend to consume higher amounts of foods that are high in fat and sodium due to stress and lack of time, opting for quick and convenient options that are not always the healthiest (Wu et al. 2023).

No relationship was identified between nutritional patterns and socioeconomic level and physical activity. This result is probably due to the impact cultural habits, personal preferences and nutritional knowledge have on dietary habits (Oude Groeniger et al. 2019). Although higher incomes tend to facilitate access to healthy foods and physical activity, personal motivation, time availability and health education also play an important role, leading to individual variations.

Regarding the results of the associatio between nutritional patterns and dietary intake, our analyses indicated that high values of NP1 were positively related with most dietary measures, except for carbohydrates and fats; NP2 was positively associated with energy and folate intake; and, NP3 was positively related to energy and fat intake, and negatively related to carbohydrates. These results confirm previous studies and suggest that empirical nutrient patterns are fully defined and differentiated according to their function: vitamins and minerals regulate body function, while carbohydrates and fats are sources of energy; carbohydrates and fats provide calories (energy), but vitamins and minerals do not (Singh et al. 2017).

The results concerning the comparison of the factor scores in the nutritional patterns between MHO versus MUO groups also achieved differences. Based on the HOMA-IR classification, MUO was associated with a lower mean score for NP1 (minerals and vitamins), and this evidence could explain why metabolically unhealthy obese people tend to have vitamin and mineral deficiencies. Recent studies have reported that a diet rich in ultra-processed foods, sugars, and unhealthy fats, common in this group, is low in essential nutrients such as those provided by fruit, vegetables, and whole grains (Iacobini et al. 2019; Kaidar-Person et al. 2008). In addition, other prior studies also mentioned that insulin resistance, common in metabolic obesity, affects the metabolism of these nutrients, and the accumulation of visceral fat can reduce the availability of fat-soluble nutrients, such as vitamins A, D, E, and K (Iacobini et al. 2019; Schulze 2019). The combination of these factors could contribute to a vitamin and mineraldeficiency.

Differences in psychopathological distress also emerged when comparing MHO with MUO groups. Based on the HOMA-IR classification, MUO was associated with higher levels of depression. And considering the IDF classification, MUO was associated with a worse psychological state (higher levels of anxiety, depression and stress). These results support prior studies, which suggested that MUO patients tend to have a dysfunctional psychological profile due to a set of hormonal, metabolic and psychological factors (Jokela et al. 2014). Insulin resistance and chronic inflammation, characteristic of this group, could impact the functioning of brain structures, and the neurotransmitters responsible for increased vulnerability to emotional disorders (Maciejczyk et al. 2019). Furthermore, studies have indicated that stress associated with the risk of

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chronic disease and glucose fluctuations contributes to anxiety and depression (Maciejczyk et al. 2019; Bouwman et al. 2010). Regarding the differences in the results based on the classification criteria (HOMA-IR or IDF), it must be considered that the HOMA-IR index is more sensitive to insulin resistance and specific to measuring metabolically unhealthy obesity, while IDF seems more appropriate for classifying metabolic syndrome in general based on several interrelated risk factors (abdominal obesity, high blood pressure, and lipid abnormalities) (Esteghamati et al. 2010; Ahmed et al. 2012).

Regarding the results obtained examining the mediating link of MUO in the relationship between empirical nutritional patterns and psychological status (anxiety, depression, and stress levels), we observed that lower factor scores for NP1 increased the likelihood of MUO, and this high metabolic risk profile was then associated with a worse psychological status. This result ties in with previous research. Studies indicate that MUO individuals who do not consume enough vitamins and minerals are more likely to experience anxiety, depression and stress due to several biological factors (Abiri et al. 2023; Cruz et al. 2024). Vitamins and minerals are essential for the production and regulation of neurotransmitters such as serotonin, dopamine and norepinephrine, which directly influence mood state and emotion regulation processes (Labban et al. 2020). A deficiency in key nutrients such as B vitamins, magnesium, zinc or iron can alter the balance of these neurotransmitters, increasing vulnerability to anxiety and depression (Dhailappan and Samiappan 2022). And interestingly, the lack of these essential micronutrients can also worsen chronic inflammation, a common factor in metabolically unhealthy obesity (Lapik et al. 2020). Inflammation is closely linked to mood disorders, since it affects brain function and can contribute to symptoms of anxiety and depression (Salim et al. 2012). On the other hand, a lack of essential nutrients, such as B vitamins and magnesium, can interfere with energy production in the body, which can lead to fatigue, irritability, and emotional distress (Bell 1958). Chronic fatigue and a lack of energy can increase stress levels and make it more difficult to cope with daily demands, thus contributing to emotional stress (Bell 1958; Rabasa and Dickson 2016).

In relation to the above, other studies have observed that vitamin and mineral deficiencies affect cognitive function, which would lead to difficulties in coping with stress, solving problems and decision making (Long and Benton 2013; Kaplan et al. 2007). Meanwhile, the lack of micronutrients not only affects physical and emotional states but may also make obesity management more difficult (Simpson et al. 2011). Deficiency in essential nutrients could lead to an increased desire to eat unhealthy foods, which in turn worsens metabolic health status and increases anxiety related to obesity and its consequences (Amiri and Behnezhad 2019).

In conclusion, a lack of key nutrients, such as magnesium and B vitamins, may be linked to increased stress reactivity (McCabe et al. 2017) and brain outcomes (Cordeiro et al. 2020). And MUO individuals with nutritional deficiencies could become more susceptible to experiencing high levels of anxiety and depression in response to everyday stressors (Jokela et al. 2014; Amiri and Behnezhad 2019; Casseb et al. 2019).

4.1 | Limitations

The findings of this study must be interpreted while considering some of its limitations. Firstly, anthropometry data based on weight, height and BMI may not precisely measure the proportion of body fat. Secondly, the use of a self-reporting questionnaire to measure the frequency of consumption could be influenced by memory biases and therefore provide inaccurate eating habits. In addition, the precision of the portions and the expected daily variations could affect the accurate estimation of caloric intake and macronutrient consumption. Thirdly, the glucose, insulin, triglyceride, cholesterol and HDL tests were performed at a specific time and may not reflect variability over time, which is important in the analysis of insulin resistance for the classification of MHO versus MUO. In fact, the cross-sectional nature of our data could limit the accuracy of the HOMA-IR estimation and the assessment of the participants' metabolic risk. Furthermore, due to the significant role played by vitamin and mineral status in disease prevention, these nutrients should be measured through plasma. And fourthly, mental distress/wellbeing was measured using only three types of measurement (depression, anxiety and stress levels). But it would be important to assess other psychological factors, such as sleep and quality of life (variables that have also been linked to metabolic risk in prior studies).

4.2 | Strengths

This study stands out due to its contribution toward the integration of new metabolic, psychological and dietary variables, which has also allowed for the characterisation of a phenomenon from a multi-causal perspective. For the first time, a consumption profile is available, based on nutrient patterns, useful for the characterisation of overweight and obese students and integrating the cultural particularities of Ecuador.

The use of consumption frequency questionnaires is undeniably an effective tool for large-scale observational studies, accessible, efficient in terms of time, and also provides an overview of the eating habits of the population without requiring continuous monitoring. Besides, the data retrieved through the laboratory tests provides a solid basis for evaluating the metabolic profile of participants, thus facilitating the empirical-standardised classification of MHO versus MUO subjects.

The results of this study strengthen the prevention of chronic disease since nutrition plays a fundamental role in metabolic health. Metabolic status, which includes insulin resistance, obesity, and related disorders, can predict the risk of developing chronic diseases such as type 2 diabetes, hypertension, and cardiovascular disease. Therefore, this study allows for the identification of dietary patterns that contribute to a better or worse metabolic status in this population, thus facilitating early intervention to prevent these conditions.

Finally, understanding the relationship between nutritional patterns, metabolism, and psychological status, can guide the development of evidence-based nutritional intervention programmes, aimed at improving both physical health and

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emotional well-being. Improving eating habits could be an effective strategy to reduce the prevalence of metabolic and psychological disorders, improving the quality of life of highly vulnerable populations, such as young adults. Along the same lines, our results could contribute toward the development of public policies and educational programmes that promote an overall healthy lifestyle.

Author Contributions

conceptualization, G.G.R.O. and M.A.A.Q. methodology and statistics, G.G.R.O and R.G. writing and preparation of the original draft, G.G.R.O., R.G., and M.A.A.Q. data collection and management, M.A.A.Q. and M.P.A.R. All authors have read and accepted the published version of the manuscript

Ethics Statement

The research was carried out in accordance with the latest version of the Declaration of Helsinki and was approved by the Human Research Ethics Committee of the Catholic University of Cuenca with the code: CEISH–UCACUE–045 endorsed by the Ministry of Public Health of Ecuador.

Consent

Signed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from G.G. R.O. The data are not publicly available due to containing information that could compromise the privacy of research participants.

References

Abiri, B., M. Valizadeh, L. Nasreddine, and F. Hosseinpanah. 2023. "Dietary Determinants of Healthy/Unhealthy Metabolic Phenotype in Individuals With Normal Weight or Overweight/Obesity: A Systematic Review." *Critical Reviews in Food Science and Nutrition* 63, no. 22: 5856–5873. https://doi.org/10.1080/10408398.2021.2025036.

Agius, R., N. P. Pace, and S. Fava. 2024. "Phenotyping Obesity: A Focus on Metabolically Healthy Obesity and Metabolically Unhealthy Normal Weight." *Diabetes Metab Res Rev* 2: 25–37.

Ahmed, A., T. E. Khan, T. Yasmeen, S. Awan, and N. Islam. 2012. "Metabolic Syndrome in Type 2 Diabetes: Comparison of WHO, Modified ATPIII & IDF Criteria." *Journal of the Pakistan Medical Association* 62: 569.

Almoraie, N. M., N. M. Alothmani, W. D. Alomari, and A. H. Alamoudi. 2024. "Addressing Nutritional Issues and Eating Behaviours Among University Students: A Narrative Review." *Nutrition Research Reviews* 1: 1–16. https://doi.org/10.1017/s0954422424000088.

Amiri, S., and S. Behnezhad. 2019. "Obesity and Anxiety Symptoms: A Systematic Review and Meta-Analysis." *Neuropsychiatrie: Klinik, Diagnostik, Therapie und Rehabilitation: Organ der Gesellschaft Osterreichischer Nervenarzte und Psychiater* 33, no. 2: 72–89. https://doi.org/10.1007/s40211-019-0302-9.

Barrea, L., G. Muscogiuri, G. Pugliese, G. De Alteriis, A. Colao, and S. Savastano. 2021. "Metabolically Healthy Obesity (MHO) vs. Metabolically Unhealthy Obesity (MUO) Phenotypes in PCOS: Association With Endocrine-Metabolic Profile, Adherence to the Mediterranean Diet, and Body Composition." *Nutrients* 13, no. 11: 3925. https://doi.org/10.3390/nu13113925.

Barrett, P. 2007. "Structural Equation Modelling: Adjudging Model Fit." *Pers Individ Dif.* 42, no. 5: 815–824. https://doi.org/10.1016/j.paid.2006.09.018.

Bauce, G., and M. Z. Moya-Sifontes. 2020. "Waist Circumference Weight Index as a Complementary Indicator of Overweight and Obesity in Different Groups of Subjects." *Rev. Dig. Postg* 9: e195.

Bede, F., S. N. Cumber, C. N. Nkfusai, et al. 2020. "Dietary Habits and Nutritional Status of Medical School Students: The Case of Three State Universities in Cameroon." *Pan Afr Med J* 23: 15–35. https://doi.org/10.11604/pamj.2020.35.15.18818.

Bell, E. C. 1958. "Nutritional Deficiencies and Emotional Disturbances." *Journal of Psychology* 45, no. 1: 47–74. https://doi.org/10.1080/00223980.1958.9916240.

Bentler, P. M. 1990. "Comparative Fit Indexes in Structural Models." *Psychological Bulletin* 107, no. 2: 238–246. https://doi.org/10.1037/0033-2909.107.2.238.

Bielby, W. T., and R. M. Hauser. 1977. "Structural Equation Models." *Annual Review of Sociology* 3, no. 1: 137–161. https://doi.org/10.1146/annurev.so.03.080177.001033.

Blüher, M. 2020. "Metabolically Healthy Obesity." *Endocrine Reviews* 3: 12–15.

Blüher, S., and P. Schwarz. 2014. "Metabolically Healthy Obesity From Childhood to Adulthood – Does Weight Status Alone Matter?" *Metabolism* 63, no. 9: 1084–1092. https://doi.org/10.1016/j.metabol.2014.06.009.

Bojorquez, I., C. Unikel, I. Cortez¸ D. Cerecero. 2015. "The Social Distribution of Dietary Patterns. Traditional, Modern and Healthy Eating Among Women in a Latin American City." *Appetite* 92: 43–50. https://doi.org/10.1016/j.appet.2015.05.003.

Bourdier, L., M. Fatseas, A. S. Maria, A. Carre, and S. Berthoz. 2020. "The Psycho-Affective Roots of Obesity: Results From a French Study in the General Population." *Nutrients* 10: 29–62. https://doi.org/10.3390/nu12102962.

Bouwman, V., M. C. Adriaanse, E. van't Riet, F. J. Snoek, J. M. Dekker, and G. Nijpels. 2010. "Depression, Anxiety and Glucose Metabolism in the General Dutch Population: The New Hoorn Study." *PLoS One* 5, no. 4: 9971. https://doi.org/10.1371/journal.pone.0009971.

Buccini, G., and D. Wolfthal. 2008. "Cut-Off Values for Insulin Resistance, Insulin Sensitivity and Insulin Secretion Indices Derived From the HOMA Formula and the HOMAZ Program, Interpretation of the Data. Argent. J." *Endocr. Metab.* 45: 3–21.

Çakmak, S., and Ö Tanrıöver. 2024. "Is Obesity and Body Perception Disturbance Related to Social Media Addiction Among University Students?" *J Am Coll Health J ACH* 72, no. 1: 302–309. https://doi.org/10.1080/07448481.2022.2034832.

Casseb, G. A., M. P. Kaster, and A. L. S. Rodrigues. 2019. "Potential Role of Vitamin D for the Management of Depression and Anxiety." *CNS Drugs* 33, no. 7: 619–637. https://doi.org/10.1007/s40263-019-00640-4.

Choi, J. 2020. "Impact of Stress Levels on Eating Behaviors Among College Students." *Nutrients* 5: 12–41. https://doi.org/10.3390/nu12051241.

Cordeiro, A., B. Campos, S. E. Pereira, C. J. Saboya, and A. Ramalho. 2020. "Inadequacy of Vitamin D Nutritional Status in Individuals With Metabolically Unhealthy Obesity Phenotype: The Relevance of Insulin Resistance." *Diabetes, Metabolic Syndrome and Obesity* 13: 4131–4139. https://doi.org/10.2147/dmso.s256132.

Cruz, K. J. C., A. R. S. de Oliveira, L. C. Fontenelle, et al. 2024. "Relationship Between Zinc, Selenium, and Magnesium Status and Markers of Metabolically Healthy and Unhealthy Obesity Phenotypes." *Biological*

10990968, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/erv.3209 by Universidad Autonoma De, Wiley Online Library on [04/06/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Trace Element Research 202, no. 8: 3449–3464. https://doi.org/10.1007/s12011-023-03938-z.

Cumbre de Naciones Unidas sobre Sistemas Alimentarios [Internet]. 2020: March 24 2023. https://www.derechoalimentacion.org/agenda/cumbre-de-naciones-unidas-sobre-sistemas-alimentarios.

Dakanalis, A., M. Mentzelou, S. K. Papadopoulou, et al. 2023. "The Association of Emotional Eating With Overweight/Obesity, Depression, Anxiety/Stress, and Dietary Patterns: A Review of the Current Clinical Evidence." *Nutrients* 5: 17–30. https://doi.org/10.3390/nu15051173.

Dhailappan, A., and S. Samiappan. 2022. "Impact of Diet on Neurotransmitters." *Role of nutrients in neurological disorders* 1: 363–383. https://doi.org/10.1007/978-981-16-8158-5_20.

Ebrahimpour-Koujan, S., A. H. Keshteli, H. Afshar, A. Esmaillzadeh, and P. Adibi. 2019. "Adherence to Low Carbohydrate Diet and Prevalence of Psychological Disorders in Adults." *Nutrition Journal* 1: 87–97. https://doi.org/10.1186/s12937-019-0513-8.

Enriquez, J. P., and D. Ader. 2023. "Associations Between Health Issues and Food Consumption With Overweight and Obesity in Three University Students Minorities." *J Am Coll Health J ACH* 11: 1–9. https://doi.org/10.1080/07448481.2023.2266045.

Esteghamati, A., H. Ashraf, O. Khalilzadeh, et al. 2010. "Optimal Cut-Off of Homeostasis Model Assessment of Insulin Resistance (HOMA-IR) for the Diagnosis of Metabolic Syndrome: Third National Surveillance of Risk Factors of Non-Communicable Diseases in Iran (SuRFNCD-2007)." *Nutrition & Metabolism* 7: 1–8. https://doi.org/10.1186/1743-7075-7-26.

Farhadnejad, H., M. Darand, F. Teymoori, G. Asghari, P. Mirmiran, and F. Azizi. 2019. "The Association of Dietary Approach to Stop Hypertension (DASH) Diet With Metabolic Healthy and Metabolic Unhealthy Obesity Phenotypes." *Scientific Reports* 1: 186–190. https://doi.org/10.1038/s41598-019-55285-6.

Flores-Brito, P. R., D. R. Reinoso-Guadalupe, S. F. Rosero-Ordóñez, P. R. Flores-Brito, D. R. Reinoso-Guadalupe, and S. F. Rosero-Ordóñez. 2023. "Sobrepeso y obesidad autopercibidos en estudiantes universitarios. Caso: Medicina-Escuela Superior Politécnica de Chimborazo, Ecuador." *Rev Arbitr Interdiscip Cienc Salud Salud Vida.* 7: 4–14.

Garmendia, M., L. Lera, H. Sánchez, R. Uauy, and C. Albala. 2009. "Valores normativos de resistencia a la insulina mediante HOMA-IR en adultos mayores de Santiago de Chile." *Revista Medica de Chile* 137, no. 11: 1409–1416. https://doi.org/10.4067/s0034-98872009001100001.

Gómez-León Mandujano, A., S. Morales López, and C. D. J. Álvarez Díaz. 2016. "Technique for a Correct Blood Pressure Measurement in the Ambulatory Patient. Rev." *Anales de la Facultad de Medicina* 59: 49–55.

Gómez-Zorita, S., M. Queralt, M. A. Vicente, M. González, and M. P. Portillo. 2021. "Metabolically Healthy Obesity and Metabolically Obese Normal Weight: A Review." *Journal of Physiology & Biochemistry* 1: 175–189.

Gordon, A., S. Benson, S. Bird, and S. Fraser. 2009. "Resistance Training Improves Metabolic Health in Type 2 Diabetes: A Systematic Review." *Diabetes Research and Clinical Practice* 83: 157–175. https://doi.org/10.1016/j.diabres.2008.11.024.

Griban, G., V. Smiianov, N. Lyakhova, et al. 2021. "The Impact of Nutritional Quality on the Students' Health." *Acta Balneologica* 1: 43–54. https://doi.org/10.36740/abal202101107.

Guapi-Guamán, F., R. Morcillo-Valencia, E. D. R. Falcones-Barbosa, and J. Mina-Gonzáles. 2022. "Prevalencia de sobrepeso y obesidad. Problema de salud en la comunidad universitaria y politécnica ecuatoriana." *Rev Arbitr Interdiscip Cienc Salud Salud Vida* 6: 12–58.

Haapala, I., R. Prättälä, K. Patja, et al. 2012. "Age, Marital Status and Changes in Dietary Habits in Later Life: A 21-Year Follow-Up Among Finnish Women." *Public Health Nutrition* 15, no. 7: 1174–1181. https://doi.org/10.1017/s1368980012000602.

Hu, M., Q. Shi, S. Sun, et al. 2022. "Effect of a Low-Carbohydrate Diet With or Without Exercise on Anxiety and Eating Behavior and Associated Changes in Cardiometabolic Health in Overweight Young Women." *Frontiers in Nutrition* 6: 9–16. https://doi.org/10.3389/fnut.2022.894916.

Iacobini, C., G. Pugliese, C. B. Fantauzzi, M. Federici, and S. Menini. 2019. "Metabolically Healthy Versus Metabolically Unhealthy Obesity." *Metabolism* 92: 51–60. https://doi.org/10.1016/j.metabol.2018.11.009.

Jakubiak, G. K., K. Osadnik, M. Lejawa, S. Kasperczyk, T. Osadnik, and N. Pawlas. 2021. "Oxidative Stress in Association With Metabolic Health and Obesity in Young Adults." *Oxidative Medicine and Cellular Longevity* 26: 73–52.

Jokela, M., M. Hamer, A. Singh-Manoux, G. D. Batty, and M. Kivimäki. 2014. "Association of Metabolically Healthy Obesity With Depressive Symptoms: Pooled Analysis of Eight Studies." *Molecular Psychiatry* 19, no. 8: 910–914. https://doi.org/10.1038/mp.2013.162.

Kaidar-Person, O., B. Person, S. Szomstein, and R. J. Rosenthal. 2008. "Nutritional Deficiencies in Morbidly Obese Patients: A New Form of Malnutrition? Part A: Vitamins." *Obesity Surgery* 18, no. 7: 870–876. https://doi.org/10.1007/s11695-007-9349-y.

Kaplan, B. J., S. G. Crawford, C. J. Field, and J. S. A. Simpson. 2007. "Vitamins, Minerals, and Mood." *Psychological Bulletin* 133, no. 5: 747–760. https://doi.org/10.1037/0033-2909.133.5.747.

Karamati, M., M. Yousefian-Sanni, S. E. Shariati-Bafghi, and B. Rashidkhani. 2024. "Major Nutrient Patterns and Bone Mineral Density Among Postmenopausal Iranian Women." *Calcified Tissue International* 94, no. 6: 648–658. https://doi.org/10.1007/s00223-014-9848-5.

Karra, P., M. Winn, S. Pauleck, et al. 2022. "Metabolic Dysfunction and Obesity-Related Cancer: Beyond Obesity and Metabolic Syndrome." *Obesity* 7: 1323–1334. https://doi.org/10.1002/oby.23444.

Kataoka, J., M. Olsson, E. Lindgren, et al. 2024. "Effects of Weight Loss Intervention on Anxiety, Depression and Quality of Life in Women With Severe Obesity and Polycystic Ovary Syndrome." *Scientific Reports* 1: 34–95. https://doi.org/10.1038/s41598-024-63166-w.

Kline, R. B. 2005. *Principles and Practice of Structural Equation Modeling*. 2nd ed. Guilford Press.

Labban, R. S. M., H. Alfawaz, A. T. Almnaizel, et al. 2020. "High-Fat Diet-Induced Obesity and Impairment of Brain Neurotransmitter Pool." *Translational Neuroscience* 11, no. 1: 147–160. https://doi.org/10.1515/tnsci-2020-0099.

Lapik, I. A., A. V. Galchenko, and K. M. Gapparova. 2020. "Micronutrient Status in Obese Patients: A Narrative Review." *Obesity Medicine* 18, no. 1: 200–224. https://doi.org/10.1016/j.obmed.2020.100224.

Li, X., C. Wu, J. Lu, et al. 2020. "Cardiovascular Risk Factors in China: A Nationwide Population-Based Cohort Study." *Lancet Public Health* 12: 672–681. https://doi.org/10.1016/s2468-2667(20)30191-2.

Lin, X., and H. Li. 2021. "Obesity: Epidemiology, Pathophysiology, and Therapeutics." *Frontiers in Endocrinology* 12: 69–78. https://doi.org/10.3389/fendo.2021.706978.

Long, S. J., and D. Benton. 2013. "Effects of Vitamin and Mineral Supplementation on Stress, Mild Psychiatric Symptoms, and Mood in Nonclinical Samples: A Meta-Analysis." *Psychosomatic Medicine* 75, no. 2: 144–153. https://doi.org/10.1097/psy.0b013e31827d5fbd.

Maciejczyk, M., E. Żebrowska, and A. Chabowski. 2019. "Insulin Resistance and Oxidative Stress in the Brain: What's New?" *International Journal of Molecular Sciences* 20, no. 4: 874. https://doi.org/10.3390/ijms20040874.

10990968, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/erv.3209 by Universidad Autonoma De, Wiley Online Library on [04/06/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Mathis, B. J., K. Tanaka, and Y. Hiramatsu. 2023. "Metabolically Healthy Obesity: Are Interventions Useful?" *Curr Obes Rep* 1: 36–60. https://doi.org/10.1007/s13679-023-00494-4.

McCabe, D., K. Lisy, C. Lockwood, and M. Colbeck. 2017. "The Impact of Essential Fatty Acid, B Vitamins, Vitamin C, Magnesium and Zinc Supplementation on Stress Levels in Women: A Systematic Review." *JBI Evidence Synthesis* 15, no. 2: 402–453. https://doi.org/10.11124/jbisrir-2016-002965.

Mehta, M., R. Izurieta, A. Nishio, R. Horita, and M. Yamamoto. 2023. "Nutritional Intake and Metabolic Parameters of Japanese University Students With and Without Obesity: Sex-Specific Differences." *PLoS One* 18, no. 5: 28–50. https://doi.org/10.1371/journal.pone.0285088.

Mendonça, F., P. Soares, T. Moreno, et al. 2024. "Distinguishing Health-Related Parameters Between Metabolically Healthy and Metabolically Unhealthy Obesity in Women." *International Journal of Obesity* 7: 1027–1035.

Morejón, Y., A. Manzano, S. Betancourt, and V. Ulloa. 2021. "Construction of a Food Consumption Frequency Questionnaire for Ecuadorian Adults, Cross-Sectional Study." *Revista Española de Nutrición Humana y Dietética* 25: 394–402.

Mousavi, S. M., A. Jayedi, Y. Jalilpiran, M. Hajishafiee, A. Aminianfar, and A. Esmaillzadeh. 2022. "Dietary Intake of Total, Animal and Plant Proteins and the Risk of Coronary Heart Disease and Hypertension: A Systematic Review and Dose-Response Meta-Analysis of Prospective Cohort Studies." *Critical Reviews in Food Science and Nutrition* 5: 1336–1349. https://doi.org/10.1080/10408398.2020.1841730.

Nieto, O., E. Cardona, D. Ramírez, M. González, and J. Castaño. 2020. "Obesity and Inflammation in Students of a Colombian Public University." *Annual Review of Public Health* 22: 582–588.

Nutrimind. "Software de Nutrición." accessed July 18, 2024. https://www.nutrimind.net/.

Obirikorang, C., E. A. Adu, E. O. Anto, et al. 2024. "Prevalence and Risk Factors of Obesity Among Undergraduate Student Population in Ghana: An Evaluation Study of Body Composition Indices." *BMC Public Health* 24: 1–12. https://doi.org/10.1186/s12889-023-17175-5.

Oude Groeniger, J., C. B. Kamphuis, J. P. Mackenbach, M. A. Beenackers, and F. J. van Lenthe. 2019. "Are Socio-Economic Inequalities in Diet and Physical Activity a Matter of Social Distinction? A Cross-Sectional Study." *International Journal of Public Health* 64, no. 7: 1037–1047. https://doi.org/10.1007/s00038-019-01268-3.

Palma-Leal, X., C. Costa-Rodríguez, Y. Barranco-Ruiz, S. Hernández-Jaña, and F. Rodríguez-Rodríguez. 2022. "Reliability of the International Physical Activity Questionnaire (IPAQ)-Short Version and the Physical Fitness Self-Assessment Questionnaire (IFIS) in Chilean University Students." *Journal of Mental Health* 19: 1–12.

Pan American Health Organization. "PAHO/WHO Obesity Prevention - OPS/OMS PAHO." accessed July 16, 2024. https://www.paho.org/es/temas/prevencion-obesidad.

Pasdar, Y., S. Moradi, N. H. Esfahani, M. Darbandi, and P. Niazi. 2020. "Intake of Animal Source Foods in Relation to Risk of Metabolic Syndrome." *Prev Nutr Food Sci* 2: 133–139. https://doi.org/10.3746/pnf.2020.25.2.133.

Piché, M. E., A. Tchernof, and J. P. Després. 2020. "Obesity Phenotypes, Diabetes, and Cardiovascular Diseases." *Circulation Research* 22: 112–114.

PUCE. September 20, 2022. "Geografía y clima del Ecuador." *Edupuce*: [Internet]. https://bioweb.bio/faunaweb/amphibiaweb/GeografiaClima/.

Rabasa, C., and S. L. Dickson. 2016. "Impact of Stress on Metabolism and Energy Balance." *Current Opinion in Behavioral Sciences* 9: 71–77. https://doi.org/10.1016/j.cobeha.2016.01.011.

Román, F., P. Santibáñez, and E. V. Vinet. 2016. "Use of the Depression Anxiety Stress Scales (DASS-21) as a Screening Instrument in Young People With Clinical Problems." *Act. Investig. Psicol.* 6: 2325–2336.

Rosenbloom, C. A., and F. J. Whittington. 1993. "The Effects of Bereavement on Eating Behaviors and Nutrient Intakes in Elderly Widowed Persons." *Journal of Gerontology* 48, no. 4: S223–S229. https://doi.org/10.1093/geronj/48.4.s223.

Rouhani, P., S. Mirzaei, A. Asadi, M. Akhlaghi, P. Saneei. 2023, "Nutrient Patterns in Relation to Metabolic Health Status in Overweight and Obese Adolescents." *Scientific Reports* 13, no. 1: 11–19. https://doi.org/10.1038/s41598-023-27510-w.

Salim, S., G. Chugh, and M. Asghar. 2012. "Inflammation in Anxiety." *Advances in Protein Chemistry and Structural Biology* 88: 1–25. https://doi.org/10.1016/b978-0-12-398314-5.00001-5.

Saltzgiver, S., A. Nielson, H. Costello, A. Baker, J. Chan, and D. Aguilar. 2019. "Dietary Determinants of Metabolic Syndrome Parameters Differ by Gender in College Students." *Nutrients* 12: 28–92. https://doi.org/10.3390/nu11122892.

Schulze, M. B. 2019. "Metabolic Health in Normal-Weight and Obese Individuals." *Diabetologia* 62, no. 4: 558–566. https://doi.org/10.1007/s00125-018-4787-8.

Sharda, K., P. Saxena, S. K. Yadav, et al. 2023. "To Estimate the Prevalence of Obesity and High Blood Pressure Among Undergraduate Students at a University Medical Institution in North India." *Journal of the Association of Physicians of India* 11: 30–35.

Simpson, J. L., L. B. Bailey, K. Pietrzik, B. Shane, and W. Holzgreve. 2011. "Micronutrients and Women of Reproductive Potential: Required Dietary Intake and Consequences of Dietary Deficienty or Excess. Part II-Vitamin D, Vitamin A, Iron, Zinc, Iodine, Essential Fatty Acids." *Journal of Maternal-Fetal and Neonatal Medicine* 24: 1–24. https://doi.org/10.3109/14767051003678226.

Singh, P., R. K. Kesharwani, and R. K. Keservani. 2017. "Protein, Carbohydrates, and Fats: Energy Metabolism." *Sustained Energy for Enhanced Human Functions and Activity* 1: 103–115.

Song, Z., M. Gao, J. Lv, et al., 2022. "Metabolically Healthy Obesity, Transition to Unhealthy Phenotypes, and Type 2 Diabetes in 0.5 Million Chinese Adults: The China Kadoorie Biobank." *European Journal of Endocrinology* 2: 233–244. https://doi.org/10.1530/eje-21-0743.

Stevens, S. L. 2021. "Fat-Soluble Vitamins." *Nursing Clinics* 56, no. 1: 33–45. https://doi.org/10.1016/j.cnur.2020.10.003.

Szmodis, M., A. Zsákai, G. Blaskó, et al. 2022. "Effects of Regular Sport Activities on Stress Level in Sporting and Non-Sporting University Students." *Physics International* 2: 293–304.

Taherifard, E., E. Taherifard, M. Jeddi, et al. 2024. "Prevalence of Metabolically Healthy Obesity and Healthy Overweight and the Associated Factors in Southern Iran: A Population-Based Cross-Sectional Study." *Health Science Reports* 2: 19–09.

Tanriover, C., S. Copur, A. Gaipov, et al. May 2023. "Metabolically Healthy Obesity: Misleading Phrase or Healthy Phenotype?" *European Journal of Internal Medicine* 111: 5–20. https://doi.org/10.1016/j.ejim.2023.02.025.

Taylor, R. 1990. "Interpretation of the Correlation Coefficient: A Basic Review." *Journal of Diagnostic Medical Sonography* 6, no. 1: 35–39. https://doi.org/10.1177/875647939000600106.

Telle-Hansen, V. H., J. J. Christensen, G. A. Formo, K. B. Holven, and S. M. Ulven. 2020. "A Comprehensive Metabolic Profiling of the Metabolically Healthy Obesity Phenotype." *Lipids in Health and Disease* 1: 80–90.

Teymoori, F., E. Mokhtari, P. Salehi, F. Hosseini-Esfahani, P. Mirmiran, and F. A. Azizi. 2021. "Nutrient Pattern Characterized by Vitamin A, C, B6, Potassium, and Fructose Is Associated With Reduced Risk of Insulin-Related Disorders: A Prospective Study Among Participants of

10990968, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/erv.3209 by Universidad Autonoma De, Wiley Online Library on [04/06/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Tehran Lipid and Glucose Study." *Diabetology & Metabolic Syndrome* 26: 1–13.

Tsatsoulis, A., and S. A. Paschou. June 2020. "Metabolically Healthy Obesity: Criteria, Epidemiology, Controversies, and Consequences." *Curr Obes Rep* 9, no. 2: 109–120. https://doi.org/10.1007/s13679-020-00375-0.

Vera-Ponce, V. J., F. E. Zuzunaga-Montoya, L. E. M. Vásquez-Romero, et al. 2024. "Prevalence and Factors Associated With Unhealthy Metabolic Status According to Body Mass Index: Analysis of a National Nutritional Survey." *Diabetology & Metabolic Syndrome* 16, no. 1: 186.

Volpp, K. G., S. A. Berkowitz, S. V. Sharma, et al., and American Heart Association. 2023. "Food Is Medicine: A Presidential Advisory From the American Heart Association." *Circulation* 18: 1417–1439. https://doi.org/10.1161/cir.0000000000001182.

Wang, J., X. Ran, J. Ye, et al. 2022. "Obesity-Associated Anxiety Is Prevalent Among College Students and Alleviated by Calorie Restriction." *Nutrients* 17: 3518. https://doi.org/10.3390/nu14173518.

Wang, Z., Y. Cheng, Y. Li, et al. 2022. "The Relationship Between Obesity and Depression Is Partly Dependent on Metabolic Health Status: A Nationwide Inpatient Sample Database Study." *Frontiers in Endocrinology* 25: 2–30. https://doi.org/10.3389/fendo.2022.880230.

WHO, Ginebra: OMS. "Overweight and Obesity." accessed September 1, 2024. https://www.who.int/es/news-room/fact-sheets/detail/obesity-and-overweight.

World Obesity Federation. March 2023. World Obesity Atlas. https://data.worldobesity.org/publications/?cat=19.

Wu, M., Y. Xi, J. Huo, et al. 2023. "Association Between Eating Habits and Sodium Intake Among Chinese University Students." *Nutrients* 15, no. 7: 1570. https://doi.org/10.3390/nu15071570.

Yamamoto, R., R. Tomi, M. Shinzawa, et al. 2021. "Associations of Skipping Breakfast, Lunch, and Dinner With Weight Gain and Overweight/Obesity in University Students: A Retrospective Cohort Study." *Nutrients* 1: 13–19.

Yannakoulia, M., D. Panagiotakos, C. Pitsavos, Y. Skoumas, and C. Stafanadis. 2008. "Eating Patterns May Mediate the Association Between Marital Status, Body Mass Index, and Blood Cholesterol Levels in Apparently Healthy Men and Women From the ATTICA Study." *Social Science & Medicine* 66, no. 11: 2230–2239. https://doi.org/10.1016/j.socscimed.2008.01.051.

Zamil, A. H., and S. S. Amin. 2022. "The Prevalence of Metabolic Syndrome Among University Students in Wasit, Iraq." *Saudi Medical Journal* 11: 1–43. https://doi.org/10.15537/smj.2022.43.11.20220558.

Zhang, J., T. Xu, Y. Huang, et al. 2024. "Sex Differences in the Relationships Between Macronutrients and All-Cause Mortality in Individuals With Metabolically Unhealthy Overweight/obesity." *Nutrition* 122: 23–93. https://doi.org/10.1016/j.nut.2024.112393.

Zhang, R., Z. Wang, Y. Fei, et al. 2015. "The Difference in Nutrient Intakes Between Chinese and Mediterranean, Japanese and American Diets." *Nutrients* 7, no. 6: 4661–4688. https://doi.org/10.3390/nu7064661.

Zhang, Y., Y. Li, T. Jiang, and Q. Zhang. 2023. "Role of Body Mass Index in the Relationship Between Adverse Childhood Experiences, Resilience, and Mental Health: A Multivariate Analysis." *BMC Psychiatry* 23, no. 1: 40–60. https://doi.org/10.1186/s12888-023-04869-8.

10990968, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/erv.3209 by Universidad Autonoma De, Wiley Online Library on [04/06/2025]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License