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Dietary Patterns and Dietary Recommendations Achievement From Latin American College Students During the COVID-19 Pandemic Lockdown

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This study aimed to compare the diet quality of different dietary patterns among college students from Latin American countries, including vegetarians, vegans, and omnivores during the COVID-19 pandemic. A cross-sectional, observational, multicenter study was conducted including a non- probabilistic sample of university students from 10 countries. University students were invited to participate in the study through social network platforms. Participants were self-reported to have followed a specific dietary pattern; either the Prudent diet, Western diet, Ovo-dairy-vegetarian diet, Fish-vegetarian diet, Strict vegetarian diet (vegan) or other. The last three patterns (vegetarians and vegans) were grouped as following a plant-based diet. A self-assessment survey was used to evaluate healthy eating habits using a questionnaire with values between 1 (do not consume) and 5 (consume) for a total of 9–45 points (higher values represent better eating habits). Unhealthy habits were assessed with nine questions. A total of 4,809 students filled out the questionnaire, and the majority of them were females (73.7%).

A high percentage have been in lockdown for more than 5 months and were in lockdown when the survey was released. 74.3% were self-reported to follow a prudent diet, while 11.4% reported following a western dietary pattern and 8.8% a plant-based diet. When compliance with healthy and unhealthy dietary habits was analyzed, although all groups had low compliance, the plant-based diet group (56.09 ± 6.11) performed better than the Western diet group (48.03 ± 5.99). The total diet quality score was significantly higher for plant-based diet followers, who also tended to better achieve the recommendations than omnivorous students, especially the ones following a western diet. These results present evidence that young adults such as college-aged students have unhealthy dietary habits. However, the ones who follow a plant-based diet such as vegetarians and vegans exhibit better scores and healthier dietary conducts.

Keywords: dietary patterns, vegetarians, vegans, omnivorous, COVID lockdown

INTRODUCTION

Latin America is one of the world's regions with a higher prevalence of risk factors of non-communicable diseases (NCDs) such as cardiovascular disease, cerebrovascular disease, type II diabetes (T2D) and hypertension (Anauati et al., 2015; Pan American Health Organization and World Health Organization, 2016). In addition to elevated morbidity, NCDs also exhibit a high mortality rate (Barquera et al., 2015; Kimokoti and Millen, 2016; Calazans and Queiroz, 2020; Lee et al., 2020).

Diet being a determinant factor of NCDs, the Latin American Study of Nutrition and Health (Estudio Latino Americano de Nutrición y Salud ELANS), a household-based cross-sectional survey conducted from March 2014 to December 2015, provided insight into different aspects of diet quality in adolescents and adults from eight Latin American countries (Fisberg et al., 2016), reporting that only 7.2% of the overall sample reached the World Health Organization's recommendations for fruits and vegetables consumption, and <3.5% met the optimal consumption level of vegetables, nuts, whole grains, fish and yogurt, highlighting the urgency of improving dietary habits in order to prevent NCDs and improve health (Kovalskys et al., 2019). This suboptimal intake of nutrient-dense food groups and healthy food groups was more frequently observed in younger rather than older adults (Kovalskys et al., 2019). Particularly, participants aged 20–34 years were more vulnerable to high total and added sugar intake than older age groups, with a mean of 20.1% of total energy intake from added sugar (Fisberg et al., 2018). This pre-pandemic data showed a huge gap between healthy food groups and micronutrients intake and recommendations that urged actions to improve diet quality in this population.

In terms of nutrition behavior, university students are a highly vulnerable population since they are still defining their dietary and lifestyle patterns. While some students show a tendency to adopt risky habits such as alcohol intake and tobacco use, snacking, skipping meals, physical inactivity, and inadequate sleep (Kimokoti and Millen, 2016; Sogari et al., 2018; Rodrigues et al., 2019), others gain interest in more nutrient-dense and environmental-conscious patterns such as vegetarianism and veganism. Although this trend includes different age groups, it is especially popular among younger populations such as college students and adolescents (Larsson and Johansson, 2002; Clarys et al., 2014; Segovia-Siapco et al., 2019; Sakkas et al., 2020).

Recent studies have shown that dietary patterns analysis is a cost-effective way to assess nutrient consumption. It has been shown that dietary patterns assessment is a good predictor of chronic disease risk, even more than individual nutrients or foods groups analysis, because it takes a look at a broader picture which is the individual's whole diet (Hu, 2002). Dietary pattern analysis provides comprehensive information about combined and synergistic relations between foods and nutrients consumed (Castro et al., 2015).

The western diet has been associated with an increased risk for NCDs, including the increasing prevalence of obesity (Kopp, 2019) in both developed and developing countries (Salameh et al., 2014). This pattern is characterized by its high caloric density that comes from ultra-processed foods, soft drinks, fast foods, alcohol and snacks (Cunnane, 2005; López-Taboada et al., 2020). People who follow this pattern have a high intake of trans, saturated and omega-6 polyunsaturated fatty acids, simple sugars and other high glycemic index carbohydrates, with little consumption of omega 3 fatty acids, dietary fiber, and some micronutrients and antioxidants. In general, it is the least nutrient-dense dietary pattern (Statovci et al., 2017; Kopp, 2019).

The prudent diet was proposed in the 1970's as a response to the increased prevalence in NCDs. In this diet, four principles are suggested: Avoid excessive caloric intake, increase dietary fiber, reduce total fat intake and increase polyunsaturated fatty acids in the diet (Mann, 1979).

Over the years, western societies including Latin American countries, have shown an increased interest in plant-based dietary patterns. For example, vegetarianism, which excludes certain food items such as meat, poultry, or fish; or veganism, which completely avoids all types of meat and animal products such as dairy and eggs (Tuso et al., 2013; Medawar et al., 2019). These increasingly popular diets focus on the consumption of fruits, vegetables, grains, nuts, seeds, mushrooms, and vegetable fats and oils (Sakkas et al., 2020).

There are many epidemiological studies that suggest that following a plant-based dietary pattern may be protective against many unhealthy outcomes related to western omnivore diets, such as obesity and chronic illness like T2D, hypertension, cardiovascular disease and, certain types of cancer (Craig, 2010; Tuso et al., 2013; Parker and Vadiveloo, 2019). This healthier status may respond to a lower intake of calories, saturated fat, and sodium as well as higher consumption of dietary fiber, polyphenols, carotenoids and, antioxidant vitamins (Sakkas et al., 2020). In addition, after shifting to a plant-based diet, many people have also adopted other healthy habits such as increased physical activity and abstinence from smoking and drinking alcohol (Cramer et al., 2017). On the other hand, there is also a strong body of evidence pointing out that the consumption of meat, seafood, eggs, and dairy products ensures meeting the dietary requirement for nutrients that are usually low or not as bioavailable in plant-based products, such as long-chain omega-3 fatty acids, vitamins D and B12, iron, iodine, calcium, and zinc (Craig, 2010; Clarys et al., 2014; Poinsot et al., 2020; Sakkas et al., 2020), which increases the need of nutrient supplementation and nutritional education to vegetarian and vegan individuals.

Since February of 2020, the COVID-19 pandemic forced countries in Latin America and the Caribbean to adopt several measures to control the virus outbreak and infection rate. These measures included social distancing, closing international borders, local public spaces and schools, instituting curfews, and quarantines (Garcia et al., 2020). Mandatory lockdown, in particular, has impacted people's lifestyles and habits. Some studies have shown that confined individuals reduced their physical activity and increased sedentary behavior (Dor-Haim et al., 2021; Sadarangani et al., 2021; Stockwell et al., 2021; Van Langen and Generali, 2021). It has also been documented that during quarantine, individuals changed some dietary habits. Some shifted toward unhealthy patterns by increasing sugar, alcohol, snacks and ultra-processed foods (UPFs) intake while decreasing the consumption of fresh products such as fruits and vegetables whereas some adopted better-eating behaviors and higher adherence to healthy dietary patterns (Bracale and Vaccaro, 2020; Celia et al., 2020; Di Renzo et al., 2020; Pellegrini et al., 2020; Bennett et al., 2021; Enriquez-Martinez et al., 2021; Pertuz-Cruz et al., 2021). It has been reported that no significant differences have been found regarding complete food group patterns, which means that vegetarians were not likely to become omnivorous, or western dieters did not turn vegan because of the COVID-19 lockdown (Husain and Ashkanani, 2020). However, there is data suggesting that individuals who followed a western-like dietary pattern did shift toward a more prudent diet, most likely to reinforce immune function (Madan et al., 2021; Navarro-Pérez et al., 2021).

Although several studies have characterized the university students' diet in the Latin American region, to our knowledge, this is the first in doing so comparing different dietary patterns. This study aimed to compare the diet quality of different dietary patterns among college students from Latin American countries, including vegetarians, vegans, and, omnivores during the COVID-19 pandemic lockdown in 2020.

METHODS

Study Design

A cross-sectional, observational, multicenter study was conducted using a non-probability sampling of uncontrolled distribution of instruments, a technique where participation is voluntary and self-selected (Schonlau et al., 2021), including university students from 10 Latin American Countries (Argentina, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Mexico, Panama, Paraguay and Peru). Students actively enrolled in higher education institutes, 18 years of age or older, were eligible for inclusion. Those who did not complete the entire survey were excluded.

Data Collection

Participants were recruited from the 10 countries mentioned above by convenience sampling. University students were invited to participate in the study through social network platforms (Instagram, Facebook, and Twitter) or institutional emails. In order to participate, individuals have to be 18 years old or older and accept an online informed consent. A self-administrated digital questionnaire in Google Forms format was used to collect eating habits and physical activity information. Data was collected between November and December 2020. Sample size calculation determined a minimum of 1,194 participants. Sample size calculation was performed using G*Power (Erdfelder et al., 2009) (considering the performance of a logistic regression, a unilateral test, an Odds ratio = 1.3, Pr (Y = 1 |X = 1) H0 = 0.2, an α of 0.01 and a power (1-β) of 0.9.

Dietary Patterns

Participants self-reported to have followed a specific dietary pattern based on the following question, "Which of the following eating patterns best describes you?," and the following choices:

- Prudent diet: Characterized by a prudent and modest intake of all food groups, without excess or avoidance.
- Western diet: Characterized by a high intake of ultra-processed and fast foods such as pizza, burgers, fries, snacks, frozen, canned or fried foods. Also, a low intake of fruits, vegetables, legumes and whole-grain cereals.
- Ovo-dairy-vegetarian diet: A plant-based diet that includes dairy and eggs
- Fish-vegetarian diet: A plant-based diet that includes fish, dairy and eggs.
- Strict vegetarian diet (vegan): Characterized by the sole consumption of foods of vegetable origin.
- Other diet: For those who do not identify with any pattern stated before.

For the main analysis, people who answered Ovo-dairy-vegetarian diet, Fish-vegetarian diet or Strict vegetarian diet (vegan) were grouped as following a plant-based diet.

Eating Habits

Eating habits were assessed using a self-administered food habits survey, following a methodology proposed and adapted by Crovetto et al. (2018) according to the Chilean dietary

TABLE 1 | Sociodemographic characteristics by dietary pattern.

	General	Prudent diet	Western diet	Plant Based diet	Other diet
n (%)	4,859 (100)	3,610 (74.3)	554 (11.4)	428 (8.8)	267 (5.5)
Age	22.4 (4.34)	22.2 (4.24)	22.8 (4.33)	22.9 (4.71)	22.7 (4.96)
Sex					
Male	1,280 (26.3)	929 (25.7)	183 (33.0)	88 (20.6)	80 (30.0)
Female	3,579 (73.7)	2,681 (74.3)	371 (67.0)	340 (79.4)	187 (70.0)
Country					
Argentina	503 (10.4)	338 (9.4)	50 (9.0)	98 (22.9)	17 (6.4)
Colombia	273 (5.6)	217 (6.0)	27 (4.9)	19 (4.4)	10 (3.7)
Chile	376 (7.7)	261 (7.2)	24 (4.3)	72 (16.8)	19 (7.1)
Costa Rica	584 (12.0)	452 (12.5)	57 (10.3)	47 (11.0)	28 (10.5)
Ecuador	673 (13.9)	523 (14.5)	77 (13.9)	35 (8.2)	38 (14.2)
Guatemala	375 (7.7)	278 (7.7)	52 (9.4)	31 (7.2)	14 (5.2)
Mexico	1,242 (25.6)	926 (25.7)	142 (25.6)	93 (21.7)	81 (30.3)
Panama	293 (6.0)	221 (6.1)	48 (8.7)	10 (2.3)	14 (5.2)
Paraguay	257 (5.3)	177 (4.9)	53 (9.6)	7 (1.6)	20 (7.5)
Peru	283 (5.8)	217 (6.0)	24 (4.3)	16 (3.7)	26 (9.7)
Field of study					
Health sciences	3,093 (63.7)	2,368 (65.6)	304 (54.9)	269 (62.9)	152 (56.9)
Engineering and exact sciences	882 (18.2)	634 (17.6)	131 (23.6)	62 (14.5)	55 (20.6)
Education, social sciences and humanities	198 (4.1)	131 (3.6)	28 (5.1)	31 (7.2)	8 (3.0)
Arts, architecture and design	63 (1.3)	41 (1.1)	9 (1.6)	10 (2.3)	3 (1.1)
Management and economics sciences	156 (3.2)	114 (3.2)	25 (4.5)	11 (2.6)	6 (2.2)
Agricultural and biological sciences	207 (4.3)	147 (4.1)	16 (2.9)	30 (7.0)	14 (5.2)
Others	260 (5.4)	175 (4.8)	41 (7.4)	15 (3.5)	29 (10.9)
Year in course					
First year	953 (19.6)	677 (18.8)	110 (19.9)	108 (25.2)	58 (21.7)
Second year	1,217 (25.0)	894 (24.8)	150 (27.1)	109 (25.5)	64 (24.0)
Third year	961 (19.8)	723 (20.0)	94 (17.0)	80 (18.7)	64 (24.0)
Fourth year	766 (15.8)	579 (16.0)	85 (15.3)	67 (15.7)	35 (13.1)
Five or more years	962 (19.8)	737 (20.4)	115 (20.8)	64 (15.0)	46 (17.2)
Scholarity in household					
Primary school incomplete	325 (6.7)	219 (6.1)	54 (9.7)	25 (5.8)	27 (10.1)
Primary school	403 (8.3)	290 (8.0)	36 (6.5)	37 (8.6)	40 (15.0)
High school incomplete	396 (8.1)	282 (7.8)	51 (9.2)	37 (8.6)	26 (9.7)
Technical incomplete	1,046 (21.5)	790 (21.9)	118 (21.3)	84 (19.6)	54 (20.2)
Technical	816 (16.8)	607 (16.8)	88 (15.9)	80 (18.7)	41 (15.4)
University	1,248 (25.7)	955 (26.5)	138 (24.9)	110 (25.7)	45 (16.9)
Postgrads	625 (12.9)	467 (12.9)	69 (12.5)	55 (12.9)	34 (12.7)
Profession in household					
Medium executive	1,217 (25.0)	907 (25.1)	130 (23.5)	118 (27.6)	62 (23.2)
High executive	187 (3.8)	136 (3.8)	23 (4.2)	21 (4.9)	7 (2.6)
Workman	873 (18.0)	655 (18.1)	99 (17.9)	64 (15.0)	55 (20.6)
Administrative work	1,608 (33.1)	1,227 (34.0)	174 (31.4)	138 (32.2)	69 (25.8)
Trade job	696 (14.3)	499 (13.8)	77 (13.9)	63 (14.7)	57 (21.3)
Minor jobs	278 (5.7)	186 (5.2)	51 (9.2)	24 (5.6)	17 (6.4)

(Continued)

TABLE 1 | Continued

	General	Prudent diet	Western diet	Plant Based diet	Other diet
Time in lockdown					
None	210 (4.3)	152 (4.2)	37 (6.7)	12 (2.8)	9 (3.4)
< 1 month	119 (2.4)	90 (2.5)	9 (1.6)	14 (3.3)	6 (2.2)
1–2 months	303 (6.2)	218 (6.0)	34 (6.1)	30 (7.0)	21 (7.9)
3–5 months	853 (17.6)	642 (17.8)	93 (16.8)	79 (18.5)	39 (14.6)
More than 5 months	3,374 (69.4)	2,508 (69.5)	381 (68.8)	293 (68.5)	192 (71.9)
Currently in lockdown					
Yes	2,955 (60.8)	2,226 (61.7)	321 (57.9)	234 (54.7)	174 (65.2)
No	1,904 (39.2)	1,384 (38.3)	233 (42.1)	194 (45.3)	93 (34.8)
Type of lectures					
On Campus	29 (0.6)	19 (0.5)	3 (0.5)	6 (1.4)	1 (0.4)
Online/virtual	4,659 (95.9)	3,462 (95.9)	536 (96.8)	407 (95.1)	254 (95.1)
Mixed (on campus and virtual)	171 (3.5)	129 (3.6)	15 (2.7)	15 (3.5)	12 (4.5)

recommendations (Crovetto et al., 2018). The survey consisted of 15 items, which explore the consumption of different foods and food groups. The first nine items assessed the frequency of consumption of food groups recommended by the current Chilean dietary guidelines (dairy products, fruits, vegetables, legumes, fish, and whole grains) and the frequency of following healthy eating habits (consumption of breakfast, lunch, and dinner), ranging from no consumption (1 point), to the suggested daily/weekly portions (5 points). The suggested intake is as follows: dairy products 3 portions/d, fruits 3 units/d, vegetables ≥2 portions/d, legumes 2–3 times/w, fish ≥ 2 portion/w, whole grains ≥ 1 portion/d), obtaining a rating of the responses ranging from 9 to 45 points (higher value equivalent to better eating habits). The next six items referred to were unhealthy diet habits foods or food groups identified as promoters of NCD according to the recommendation of (≥1 portion/d of sugar sweetened beverages, ≥1 portion/d of alcohol, ≥1 portion/w of fried foods, ≥1 portion/d of fast food, ≥2 portion/d sweet snacks) and a negative food habit was added, such as adding salt to meals without tasting them; six of the questions have a score identical to the previous one (1 point, no consumption, to 5, more than three portions per day/week) and only one rated from 1 to 3 points (salt), reaching a value ranging from 7 to 33 points (higher value equivalent to worse eating habits). Both healthy and unhealthy scores were standardized on 100 points scale to facilitate comparison.

Statistical Analysis

Descriptive statistics were applied for data analysis. The quantitative data were expressed in mean and standard deviation, and qualitative data were expressed in number and percentage. Tests for trends across categories were assessed by chi-squared tests according to the distribution of the data. Analyses were conducted using R statistical software (version 4.0.3).

RESULTS

At the end of the data collection period, we ended with a database of 4,958 responses. Seventy eight students refused to participate and 71 were eliminated for incomplete data. Therefore, the present study evaluated 4,809 completed the survey correctly, which represents 96.9% of the total database.

Sociodemographic characteristics of the studied population are shown in **Table 1**. Briefly, the participants' mean age was 22.4 ± 4.3 years and were mainly females (73.7%) The percentage of men who follow a western diet pattern were slightly higher than others dietary patters. Most responses came from students in Mexico, Ecuador, and Costa Rica. The majority of the responses were obtained from health science students (63.7%). Most of them follow a prudent pattern and a lower percentage a western dietary pattern, while most of them lived with people with completed or uncompleted university or higher education. A high percentage have been in lockdown for more than 5 months and were in lockdown when the survey was released. 74.3% were self-reported to follow a prudent diet and 8.8% a plant-based diet. Among them, more than 50% were ovo-dairy-vegetarian. These were mostly from Argentina and Mexico (**Supplementary Table 1**).

A higher probability of following a prudent diet pattern was associated with living in Colombia, studying a health sciences career, being in the fifth or more years of career, and 3–5 months of time in lockdown (**Table 2**).

When analyzing the association between dietary patterns and the achievement of recommendations for healthy food groups, we found that students following a western diet had poor achievement in almost every healthy item. For instance, only 0.7% achieved the recommendation for fruits and vegetables. Meanwhile, this percentage was 15.7% for the self-reported vegetarians. Among this latter group, 75.5% achieved the legumes recommendation in comparison with 43.0% of people following a western diet. The probability of not meeting the recommendation

TABLE 2 | Association between following a prudent diet and socio-demographic characteristics.

Characteristic	OR (95% IC)
Country	
Argentina	Ref.
Chile	1.04 (0.78; 1.40)
Colombia	1.84 (1.29; 2.63)
Costa Rica	1.63 (1.24; 2.14)
Ecuador	1.50 (1.15; 1.97)
Guatemala	1.50 (1.11; 2.04)
Mexico	1.57 (1.23; 2.01)
Panama	1.64 (1.17; 2.29)
Paraguay	1.19 (0.85; 1.66)
Peru	1.65 (1.18; 2.32)
Age	0.97 (0.95; 0.98)
Field of study	
Arts, architecture and design	Ref.
Agricultural and biological sciences	1.20 (0.65; 2.19)
Health sciences	1.68 (0.98; 2.87)
Management and economics sciences	1.34 (0.71; 2.53)
Education, social sciences and humanities	1.06 (0.58; 1.94)
Engineering and exact sciences	1.28 (0.74; 2.21)
Other	1.05 (0.58; 1.90)
Year in course	
First year	Ref.
Second year	1.08 (0.89; 1.31)
Third year	1.25 (1.01; 1.55)
Fourth year	1.28 (1.01; 1.61)
Five or more years	1.45 (1.15; 1.83)
Sex	
Female	Ref.
Masculine	0.93 (0.79; 1.08)
Time in lockdown	
None	Ref
<1 month	1.19 (0.71; 2.02)
1–2 months	0.93 (0.62; 1.40)
3–5 months	1.04 (0.73; 1.47)
More than 5 months	0.98 (0.71; 1.36)

Multivariable logistic regression analyses. The dependent variable was a dummy variable indicating 1 = people with prudent diet vs. 0 = people with other diets (western, plan-based diet and other diets).

of healthy food groups was lower those following a western diet, except for dairy products (**Table 3**). In addition, students following a western diet were more likely to skip breakfast (50.4%) while more than 70% of people with a prudent and plant-based diet reported having this meal and showed a significantly lower probability of dinner and homemade meals consumption.

When plant-based dieters are further analyzed (**Supplementary Table 1**), among participants following a vegetarian diet 48.6 and 21% achieved the recommendations for vegetables and fruit intake, respectively, however, only 15.7% achieved the recommendation of 5 portions of fruits and vegetables altogether. Those students following a vegan diet

TABLE 3 | Achievement of healthy food group recommendations among dietary patterns.

	Fails the recommendation	Achieves the recommendation	OR (95% CI)
Fruits & vegetables			
Prudent diet	3,358 (93.0)	252 (7.0)	1.00 (Ref).
Western diet	550 (99.3)	4 (0.7)	0.10 (0.04; 0.27)
Plant-based diet	361 (84.3)	67 (15.7)	2.32 (1.71; 3.16)
Other diet	259 (97.0)	8 (3.0)	0.41 (0.20; 0.84)
Vegetables			
Prudent diet	2,489 (68.9)	1,121 (31.1)	1.00 (Ref).
Western diet	504 (91.0)	50 (9.0)	0.26 (0.21; 0.31)
Plant-based diet	220 (51.4)	208 (48.6)	1.76 (1.26; 2.46)
Other diet	211 (79.0)	56 (21.0)	0.38 (0.29; 0.50)
Fruits			
Prudent diet	3,214 (89.0)	396 (11.0)	1.00 (Ref).
Western diet	531 (95.8)	23 (4.2)	0.26 (0.21; 0.31)
Plant-based diet	337 (78.7)	91 (21.3)	1.59 (1.23; 2.06)
Other diet	241 (90.3)	26 (9.7)	0.52 (0.40; 0.67)
Dairy			
Prudent diet	2,545 (74.7)	860 (25.3)	1.00 (Ref).
Western diet	410 (78.7)	111 (21.3)	0.83 (0.65; 1.04)
Plant-based diet	310 (77.1)	92 (22.9)	0.72 (0.56; 0.94)
Other diet	204 (80.3)	50 (19.7)	0.76 (0.55; 1.06)
Legumes			
Prudent diet	1,527 (42.3)	2,083 (57.7)	1.00 (Ref).
Western diet	316 (57.0)	238 (43.0)	0.55 (0.45; 0.67)
Plant-based diet	105 (24.5)	323 (75.5)	3.16 (2.46; 4.05)
Other diet	141 (52.8)	126 (47.2)	0.67 (0.52; 0.88)
Fish			
Prudent diet	3,245 (89.9)	365 (10.1)	1.00 (Ref).
Western diet	526 (94.9)	28 (5.1)	0.53 (0.35; 0.79)
Plant-based diet	377 (88.1)	51 (11.9)	1.26 (0.91; 1.76)
Other diet	248 (92.9)	19 (7.1)	0.62 (0.38; 1.01)
Breakfast consumption			
Prudent diet	1,075 (29.8)	2,535 (70.2)	1.00 (Ref).
Western diet	279 (50.4)	275 (49.6)	0.41 (0.34; 0.50)
Plant-based diet	123 (28.7)	305 (71.3)	1.09 (0.86; 1.36)
Other diet	105 (39.3)	162 (60.7)	0.64 (0.50; 0.84)
Dinner consumption			
Prudent diet	2,243 (62.1)	1,367 (37.9)	1.00 (Ref).
Western diet	401 (72.4)	153 (27.6)	0.60 (0.49; 0.74)
Plant-based diet	262 (61.2)	166 (38.8)	1.00 (0.80; 1.24)
Other diet	187 (70.0)	80 (30.0)	0.73 (0.55; 0.97)
Homemade meals			
Prudent diet	966 (26.8)	2,644 (73.2)	1.00 (Ref).
Western diet	194 (35.0)	360 (65.0)	0.69 (0.57; 0.84)
Plant-based diet	149 (34.8)	279 (65.2)	0.69 (0.56; 0.87)
Other diet	83 (31.1)	184 (68.9)	0.86 (0.65; 1.14)
Oat and whole grain			
Prudent diet	1,682 (46.6)	1,928 (53.4)	1.00 (Ref).
Western diet	361 (65.2)	193 (34.8)	0.47 (0.39; 0.57)
Plant-based diet	172 (40.2)	256 (59.8)	1.37 (1.11; 1.69)
Other diet	151 (56.6)	116 (43.4)	0.64 (0.49; 0.83)

TABLE 4 | Achievement of unhealthy food groups recommendations and dietary patterns.

	Fails the recommendation	Achieves the recommendation	OR (95% CI)
Sugar-sweetened beverages			
Prudent diet	2,276 (63.0)	1,334 (37.0)	1.00 (Ref).
Western diet	458 (82.7)	96 (17.3)	0.39 (0.30; 0.49)
Plant-based diet	193 (45.1)	235 (54.9)	2.05 (1.65; 2.53)
Other diet	180 (67.4)	87 (32.6)	0.87 (0.66; 1.14)
Alcohol			
Prudent diet	1,483 (41.1)	2,127 (58.9)	1.00 (Ref).
Western diet	245 (44.2)	309 (55.8)	0.89 (0.74; 1.08)
Plant-based diet	180 (42.1)	248 (57.9)	1.19 (0.96; 1.48)
Other diet	102 (38.2)	165 (61.8)	1.08 (0.83; 1.41)
Added salt			
Prudent diet	3,133 (86.8)	477 (13.2)	1.00 (Ref).
Western diet	453 (81.8)	101 (18.2)	1.45 (1.14; 1.85)
Plant-based diet	360 (84.1)	68 (15.9)	1.26 (0.95; 1.68)
Other diet	220 (82.4)	47 (17.6)	1.31 (0.95; 1.81)
Fast food			
Prudent diet	3,061 (84.8)	549 (15.2)	1.00 (Ref).
Western diet	541 (97.7)	13 (2.3)	0.13 (0.08; 0.23)
Plant-based diet	284 (66.4)	144 (33.6)	2.88 (2.28; 3.63)
Other diet	214 (80.1)	53 (19.9)	1.31 (0.95; 1.81)
Snacks			
Prudent diet	2,871 (79.5)	739 (20.5)	1.00 (Ref).
Western diet	480 (86.6)	74 (13.4)	0.58 (0.45; 0.75)
Plant-based diet	321 (75.0)	107 (25.0)	1.19 (0.94; 1.52)
Other diet	200 (74.9)	67 (25.1)	1.26 (0.94; 1.69)
Fried food			
Prudent diet	2,871 (79.5)	739 (20.5)	1.00 (Ref).
Western diet	480 (86.6)	74 (13.4)	0.28 (0.18; 0.43)
Plant-based diet	321 (75.0)	107 (25.0)	1.99 (1.55; 2.57)
Other diet	200 (74.9)	67 (25.1)	1.12 (0.77; 1.62)

Multivariable logistic regression analyses. The dependent variable was a dummy variable indicating 1 = Achieves the recommendation vs. Fails the recommendation. The model was adjusted by age, gender, country, year in course, and period of lockdown.

were the ones who reached a higher percentage on these three guidelines, and therefore, achieved a higher dietary score.

When the analysis was done by unhealthy items (**Table 4**), most of the students failed to achieve the recommendations. But similar to healthy food groups recommendations, those who followed a Western diet had the lowest probability of achieving the recommendations. And people who follow a plant-based diet had higher proportion of people achieving the recommendations of sugar -sweetened beverages (54.9%), fast food (33.6%), and fried food (25.0%). No differences were found among plant-based diet subcategories (**Supplementary Table 2**).

Finally, When the diet quality was evaluated, the highest score was among vegetarian people (56.09 ± 6.11). Meanwhile, the lowest was for people who followed a western diet (48.03 ± 5.99). Indeed, most of the people with a western diet are in the lowest quartile of the diet quality score (**Table 5**).

DISCUSSION

This study aimed to evaluate and compare the diet quality of different dietary patterns in Latin-American college students during COVID lockdown between November and December 2020. In the current study, plant-based dieters, when compared to other students who reported following a prudent or western diets, are in the best diet quality quartiles and only 17% of them are found in the lowest quartile.

Lifestyle choices such as physical activity, smoking, alcohol consumption and dietary habits have been proven to play an important role in maintaining health and preventing diseases. Many health risk behaviors start in adolescence and young adulthood which make this population ideal to work within lifestyle interventions and prevention programs (Kimokoti and Millen, 2016; Sogari et al., 2018; Lanuza et al., 2020; Lee et al., 2020). In particular, college aged students face an important challenge: with increased independence, limited budget and spare time, healthful food choices are hard to make (Sogari et al., 2018; Sprake et al., 2018). College environment and lifestyle in Latin America include late snacking, skipping meals, fast food and alcohol intake during social events which explain why it has been repeatedly shown that there is an important weight gain during the first year of college, and this weight (which includes a fat percentage increase) is maintained throughout the whole university period (Huang et al., 2003; Lacaille et al., 2011; Santos et al., 2017). In fact, epidemiological studies have shown that the greatest weight and fat mass gain happen between 18 and 29 years of age, which include college years (Santos et al., 2017).

In this study, students were asked if they followed a prudent, western or vegetarian (which includes, for this analysis, Ovo-dairy-vegetarian, Fish-vegetarian and vegan) diet.

The results showed that the prudent diet was followed by 74.3% of the total students, and it was the most reported pattern in all the assessed countries. However, when analyzed by food group intake, most of these students fail the dietary recommendation for fruits and vegetables, dairy and fish (**Table 1**). It is important to note that the questionnaire for this study was released at a moment of lockdown due to the COVID-19 pandemic, which means that most students were having the majority of their meals at home. In fact, 73% of the individuals who self-reported a prudent diet achieved the recommendation of eating homemade meals. Similarly, Mueller et al. (2018) found that for college students, eating at home was associated with a higher adherence to this dietary pattern, and a lower prevalence of the western dietary pattern and alcohol consumption (Mueller et al., 2018). Having the opportunity or the need to eat outside their household can lead young adults to make poor health choices such as increasing their consumption of trans and saturated fats, added sugar and alcohol, habits that are more related to the western diet (Lacaille et al., 2011). However, it is important to note that during the COVID-19 emergency lockdown, several detrimental dietary changes have also been observed and reported, for example, the increase in comfort food intake such as sweets and fried foods and the increase of snacking due to anxiety (Di Renzo et al., 2020; Pellegrini et al., 2020; Bennett et al., 2021). This suggests that

TABLE 5 | Dietary score according to different dietary patterns.

	Overall	Prudent diet	Western diet	Plant-based diet	Other diet
N (%)	4,859 (100)	3,610 (74.3)	554 (11.4)	428 (8.8)	267 (5.5)
Total score mean (*SD*)	53.99 ± 6.06	54.81 ± 5.49	48.03 ± 5.99	56.09 ± 6.11	51.86 ± 5.70
Healthy dietary score by quartile *n* (%)					
Q1 Lowest	1,320 (27.2)	780 (21.6)	366 (66.1)	74 (17.3)	100 (37.5)
Q2 Medium Low	1,174 (24.2)	900 (24.9)	110 (19.9)	89 (20.8)	75 (28.1)
Q3 Medium high	1,238 (25.5)	1,018 (28.2)	57 (10.3)	98 (22.9)	65 (24.3)
Q4 Highest	1,127 (23.2)	912 (25.3)	21 (3.8)	167 (39.0)	27 (10.1)

SD, standard deviation.

during the period the survey was applied, eating at home not necessarily meant having a healthier diet.

In the present study, 11.4% of the students reported following this dietary western pattern and as expected, these failed to meet the recommendation for many healthy food groups including fruits and vegetables, dairy, fish and oats, and whole grains. In terms of unhealthy food groups, more than 80% of the western diet students failed to meet the recommendation for salt, sugar-sweetened beverages snacks, and more than 90% the ones for fast or fried foods (**Tables 3**, **4**). This trend is common in university students, for example in the study conducted by Yun et al. (2018) with college students in Brunei, most participants had the habit of snacking and consuming fried food frequently while having a low intake of fruits and vegetables (Yun et al., 2018). In Latin America, a study conducted in Chile reported that healthy foods consumption frequencies recommended by WHO and Chilean dietary guides were not achieved, and high consumption of sugar-sweetened soft drinks, alcohol, fried foods, fast food, and snacks consumption was also identified (Crovetto et al., 2018). Similar findings have also been reported in university students from Argentina (De Piero et al., 2015), Colombia (Vázquez et al., 2014), and Peru (Huamancayo-esp and Perez-c, 2019).

The third dietary pattern analyzed in this study, and reported by 8.8% of the participants was the plant-based diet, which includes ovo-dairy vegetarians, fish-vegetarians and, vegans. These dietary patterns have been receiving special interest recently, for instance, the sales of plant-based alternatives to meat and meat products grew by almost 40% between 2017 and 2019 (Davitt et al., 2021). The reasons and motivators to adopt this dietary pattern vary depending on age group, values and, beliefs; for instance, veganism and vegetarianism were usually adopted for religious reasons, however, nowadays the dietary shift also respond to ethical concerns such as animal rights and welfare, environmental impact, socioeconomic considerations, personal health and fitness concerns (Cramer et al., 2017; Clark et al., 2019; Sakkas et al., 2020; Davitt et al., 2021).

Plant-based diets aim to optimize nutrient-dense food items such as fruits, vegetables, legumes, seeds, and nuts while minimizing the consumption of calory-dense, processed foods, and animal products, although some may include dairy, eggs, and fish to some extent (Tuso et al., 2013; Miki et al., 2020). In the present study, the students who reported following a plant-based diet had the highest percentage of achievement of most of the healthy food group recommendations in comparison to the other dietary patterns (**Table 2**). This was observed for fruits and vegetables, vegetables, fruits, legumes, whole grain, and fish but not for dairy. However, among the same pattern, the recommendations were achieved by the majority of students only for the legumes and oat and whole gran categories, and vegan students were the closest to achieve the recommendations for fruits, vegetables, legumes and oats. This means that even the self-reported vegetarians or vegans failed the recommendation for many healthy food groups, such as fruits and vegetables. Although it is expected that plant-based dieters have a high intake of these food groups, it has been reported that in general, college students do not consume them as they should and in fact, the vast majority of college aged individuals fail to meet the 5 a day intake recommendation (Schroeter and House, 2015; Rodrigues et al., 2019). Alkazemi and Salmean (2021) state that this is due to taste, inconvenience and lack of knowledge on F/V intake recommendations and preparation methods (Alkazemi and Salmean, 2021) while Schroeter and House (2015) include a rising demand for fast, convenient foods and declining cooking skills to the list of intake barriers in this age group (Schroeter and House, 2015).

Regarding the unhealthy items, the plant-based diet group was the only one that achieved the recommendation for sugar sweetened drinks avoidance however, for the other categories such as fast foods, snacks and added salt, plant-based dieters did as poorly as the other groups (**Table 3**), This supports the idea that college aged individuals generally have risk related diet behaviors, independently of the dietary pattern they follow, and also, that some people choose to be vegetarian or vegan for environmental and animal welfare reasons and not always because they are concerned with their health (Vergeer et al., 2020; Davitt et al., 2021; Saintila et al., 2021).

There was a higher percentage of students achieving the recommendations for legumes and oats and whole grain among those following a vegan diet, but as expected, none of the participants following this pattern achieved the recommendations for dairy foods or fish consumption, which could lead to nutritional deficiencies such as calcium and omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Saunders et al., 2012; Bakaloudi et al., 2021). No differences on following recommendations for breakfast, dinner or homemade meals

consumption were observed when comparing the three plant-based dietary patterns. Regarding unhealthy items a higher percentage of strict-vegetarians achieved the recommendations for sugar-sweetened beverages, added salt, fast food and fried foods, while no differences were observed for alcohol and snacks consumption.

It is important to mention that there is a tendency to replace omnivorous products with plant-based substitutes that can be considered ultra-processed foods (UPFs) which are sources of sodium, saturated and trans fatty acids and refined sugar (Poti et al., 2015). Since vegetarianism and its derivatives imply just the avoidance of meat, dairy or other animal food sources, these UPFs can be highly consumed in plant-based diets, making these patterns not intrinsically healthier, as UPFs have shown to increase the risk of NCDs (Gehring et al., 2021; Jardim et al., 2021; Quinn et al., 2021).

A recent cross-sectional study conducted with French adults found that higher avoidance of animal-based foods was associated with a higher consumption of UPFs. In this study, UPFs contributed with more than 30% of the energy consumed by all participants, which is a reason for concern, however it was higher for self-reported vegans. This trend was also significantly correlated with age, meaning that the younger age commencing the plant-based pattern, the more likely it was for the participants to consume UPFs (Gehring et al., 2021). This could respond to the fact that not everyone who seeks for animal products avoidance gets proper nutritional counseling to do so, which could affect especially younger individuals such as college students, who, as mentioned before, tend to look for convenient, cheap and easy to prepare or even ready to eat goods (Mescoloto et al., 2017; Sogari et al., 2018). As Storz (2018) states, there could be also a lack of commitment in the health care community to engage patients, recommend and fully explain how to make the shift toward a plant-based diet, which usually takes time (Storz, 2018). This age association does not only apply for plant-based diets, as it has been also reported that younger individuals are more particularly associated with UPFs intake, independently of which dietary pattern they follow, as it has more to do with socioeconomic reasons (Julia et al., 2018).

Another reason why plant-based diets are recommended is sustainability. According to the EAT-Lancet Commission on healthy diets, the current dietary trends in combination with the estimated population growth not only implies a sanitary burden, but also a risk for our planet. Food production, transport, storage, cooking, and wastage contribute to greenhouse gas emissions, mineral pollution, and excessive water and land use. Therefore, a healthy diet should not only promote health to individuals but also should guarantee the conservation and rational use of natural resources, which can be obtained by shifting to a dietary pattern that includes most of its calories from plants and plant-based products (Scarborough et al., 2014; Willett et al., 2019). However, as UPFs of plant origin continue to grow, this has to be taken into consideration, as UPFs consumption is also detrimental to the environment. The production of these food items implies substantial use of natural and energetic resources, such as water and fossil fuel. One of the main purposes of UPFs is to create readily available and less perishable products, which means frozen, canned, or ready to eat goods. Under this perspective, although plant-based protein alternatives are less harmful than many meat products, as they produce fewer greenhouse gas emissions, for example (Rippin et al., 2021), this does not mean they are always sustainable. Experts suggest directing more efforts in the minimally processed vegetal choices that already exist, such as legumes, nuts, and seeds (MacDiarmid, 2021; Ohlau et al., 2022).

One of the reasons that health professionals recommend a shift to plant-based diets is the cardiovascular benefits associated with this dietary pattern. Studies have demonstrated that vegetarians have lower risk of cardiovascular disease and cardiovascular disease mortality (Kim et al., 2019; Wang et al., 2021) and show a healthier lipid profile (lower density lipoprotein and total cholesterol) when compared to omnivores (Wang et al., 2015; Rojas Allende et al., 2017; Vinay et al., 2020). However, some authors suggest that these health benefits are more influenced by the fact that usually vegetarians are more health conscious and consume more protective foods such and fruits, vegetables, fiber and antioxidants, rather than the exclusion of animal products like meat and dairy (Parker and Vadiveloo, 2019).

It is important to state that while plant-based diets have been extensively associated with favorable cardiovascular outcomes, it should be highlighted that some plant-derived foods such as refined grains, potatoes, fruit juices, and sugar-sweetened beverages have also been linked to a greater risk of cardiometabolic risk (Satija et al., 2016, 2017; Kim et al., 2021; Wang et al., 2021). In addition, even if these plant-based diets tend to include more healthy food groups, their basis is more about restricting animal products, so if it is not managed properly they can be deficient in energy, protein, omega 3 fatty acids, calcium, iron, and vitamin B-12 (Clarys et al., 2014; Blaurock et al., 2021) which can explain why it can alter some brain functions and be correlated with mental health, such as higher depression scores (Matta et al., 2018; Lee et al., 2021).

It has been shown that changes in dietary patterns can alter both the diversity and function of the gut microbiota, and the adoption of a plant-based diet is not an exception. Vegetarian diets seem to promote higher counts of certain Bacteroidetes compared with omnivores. Dietary fiber and polyphenols encourage the growth of short-chain fatty acids producer species, which improves immunity against pathogens, acts as energy fuel for intestinal cells and, promotes intestinal integrity (Tomova et al., 2019; Sakkas et al., 2020).

Despite the fact that most participants failed to meet most recommendations for both healthy and unhealthy items, when the analysis was performed according to diet score, most of the vegetarians fell in the highest quartile (39%), in comparison to 3.8% from the western diet and 25.3% from the prudent diet. Even though our study provided only a snapshot of dietary habits, our findings are in line with what has been observed in other studies with college students from not Latin American countries. In Germany, a study conducted with 61 female university students compared nutrient intake and nutritional quality between omnivores and vegetarians, reporting a higher score in those who followed a plant-based diet (Blaurock et al.,

2021). Clarys et al. (2014) used the Healthy Eating Index 2010 (HEI-2010) and the Mediterranean Diet Score (MDS) as indicators for diet quality when comparing different dietary patterns in university students from Belgium. The study reported that vegans had the lowest energy intake, better fat profile and, highest dietary fiber consumption than omnivorous and the highest HEI-2010 and MDS. Individuals who followed a non-vegan plant-based diet also obtained a better score than omnivorous students (Clarys et al., 2014). In the context of the pandemic, a French study assessed diet quality during COVID-19 lockdown compared to before, and observed a decreased in nutritional quality of diet due to modification in food choices (Marty et al., 2021). However, not all studies have found a decline in diet quality during the lockdown. Lamarche et al. (2021), reported a slight improvement in diet quality and a reduction of food insecurity in adults from Quebec during COVID-19-related early lock-down, and Di Renzo et al. (2020), reported that the population aged 18–30 years have higher adherence to the Mediterranean diet when compared with other age groups. This same study also observed that 15% of respondents turned to farmers or organic purchasing for fruit and vegetables (Di Renzo et al., 2020; Lamarche et al., 2021).

The major strength of this study is that involved a large population of university students from 10 different countries in Latin America, using the same methodology simultaneously, and provided a wide overview of their eating habits during the COVID-19 lockdown.

Given the nature of the data collection, this study is limited by the fact that a convenience sampling was used, therefore, the findings will not apply beyond the sample or could be extrapolated to other populations. Also, participants self-reported all the information which can lead to bias, misreporting, and misunderstanding of concepts. As a cross-sectional and observational study, it was not possible to assess the changes in dietary habits or patterns before and after the COVID-19 pandemic, which would help to further analyze how the lifestyle changes implied with the lockdown affected college students. More prospective studies of this kind are warranted to ensure proper nutritional handling of future public health emergencies.

CONCLUSION

This study demonstrated that in general, university students had low diet quality during the COVID-19 lockdown, which was reflected by more than 84% of the overall sample failing to meet the recommendations for fruits and vegetables, fish, added salt, fast food, and fried food.

Nevertheless, total diet quality score was significantly higher for plant-based diet followers, such as vegetarians and vegans, who also tended to better achieve the recommendations than omnivorous students, especially the ones following a western diet. These results add to the body of evidence that young adults, such as college aged students, have unhealthy dietary habits. However, the risk of short or long-term health problems may differ depending on the dietary pattern of each individual. Overall, the findings of this study support the need of developing policies, programs, and behavioral change interventions in order to improve their diet quality, nutritional status and to reduce the risk of health problems in late adulthood. It is also warranted that health professionals get updated on the latest trends regarding plant-based dietary patterns in order to give better nutritional recommendations about how to maintain a healthy but also sustainable diet. Nutritional Guides of different Latin American countries should also include adaptations for these particular populations, given the fact that they are increasing in number. This could guarantee that even young people, such as college students, regardless of what diet pattern they follow or how much time they have to prepare their meals, could make proper food choices, not only for their health and wellbeing, but also for the environment.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Scientific Ethics Committee of the University of the Americas (Chile) number 2020017. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

The data collection for each country was performed equally by each author. The statistical analysis was done by SP-S. The writing of the manuscript was done by AM and GG and was revised by SD-A and LL-D. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

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