A higher dietary restraint is associated with higher BMI: A cross-sectional study in college students.

Catalina Ramírez-Contreras[1,2], Andreu Farrán-Codina[1,2], Maria Izquierdo-Pulido[1,2#], María Fernanda Zerón-Rugerio[1,2#*]

[1]Department of Nutrition, Food Science and Gastronomy, Food Science Torribera Campus, University of Barcelona, Barcelona, Spain. [2]INSA-UB, Nutrition and Food Safety Research Institute, Barcelona, Spain. [#] Dr. Izquierdo-Pulido and Dr. Zerón-Rugerio share senior authorship. *Corresponding author.

Contact details:
Dr. María Fernanda Zerón-Rugerio. Campus de l'Alimentació. Recinte Torribera. Av. Prat de la Riba, 171 – Edifici Gaudi, Santa Coloma de Gramenet, Barcelona, 08921, Spain. E-mail: fernanda.zeron@ub.edu. Phone number: (+34) 934020907.

Author Contributions:

AFC and MIP designed the study; AFC and CRC acquired the data; CRC, MFZR and MIP analysed the data; CRC, MIP and MFZR wrote the first draft; AF and MIP revised the manuscript. All authors read and approved the final manuscript.

Transparency declaration

MIP and MFZR affirm that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. In addition, MIP and MFZR affirm that no important aspects of the study have been omitted.

ABSTRACT

Background: College students tend to have eating and lifestyle behaviors that can lead to weight gain. Paradoxically, weight gain could also lead to calorie restriction, a practice that is common among those who are concerned about their body weight. Thus, the objective of this study was to investigate the association between habits related to overweight and obesity and dietary intake, physical activity, and BMI among college students.

Methodology: One hundred ninety-two participants (18–26 years; 75% female) were included in this cross-sectional study. Participants completed the 'habits related to overweight and obesity questionnaire' which evaluates five dimensions: the concern about caloric intake, healthy eating, physical activity, alcohol consumption, and eating for psychological well-being. Additionally, anthropometric parameters, dietary intake, and physical activity were evaluated. Linear regression models were used to examine the associations between outcome and exposure variables.

Results: Higher concern about caloric intake was associated with higher BMI (1.05 kg/m^2 [95%CI: 0.58, 1.51]), but lower energy (-312.2 kcal/day [95%CI: -404.6, -219.8]) and fat intake (-1.88% [95%CI: -2.94, -0.83]). Furthermore, healthy eating was related to better diet quality 0.96 [95%CI: 0.47,1.44] and lower energy intake -231.4 kcal/day [95%CI: -367.7, -95.2]. Meanwhile, higher scores in the physical activity dimension were associated with better diet quality (0.41 [95%CI: 0.16,0.66]).

Conclusions: College students with the highest dietary restraint had the greatest BMI and the lowest energy and fat intake. Our results highlight the importance of promoting healthy behaviors among college students.

Key words: BMI, dietary intake, college students, dietary restraint, physical activity.

1. Introduction

The transition from high school to college is a time period characterized by several life changes, including leaving the parental home to attend college, as well as having greater responsibilities and independence, which can influence lifestyle and eating habits [1]. Additionally, the social environment and characteristics of the university (i.e. living arrangements or academic schedules) can influence eating behaviors among college students [2]. Along these lines, this population tend to have some dietary habits that increase their susceptibility to gain weight, including: meal skipping, nibbling and consuming larger portions of food [3–5]. In Spain, an increase in the Western dietary pattern (characterized by the presence of foods with high amounts of sugar, salt, and saturated fats) has been observed and, as a consequence, the adherence to the Mediterranean diet has decreased [6–8]. Interestingly, college students who are less likely to follow a Mediterranean diet show higher energy intake and are also more prone to engage in obesity-related behaviors, such as eating ultra-processed foods or snacks from vending machines, attending fast-food restaurants, and not choosing low-energy foods [9]. Furthermore, these changes in eating patterns have been associated with physical inactivity and can produce adverse health effects, including weight gain and obesity [10].

College students could also experience an increase in alcohol consumption [11]. In fact, it has been reported that around two-thirds of undergraduate students drink alcohol, of whom one-third get drunk [12]. It should be noted that 1 gram of alcohol provides 7.1 kcal, so alcohol intake is considered an energy intake additive to the usual dietary intake [13,14]. In consequence, higher alcohol intake can promote a positive energy balance and weight gain among heavy drinkers (understood as consuming 4 drinks on any day or more than 14 drinks per week for men and consuming 3 drinks on any day or more than 7 drinks per week for women) [13,14]. Not surprisingly, it has been observed that to compensate for the higher alcohol consumption, college students tend to consume low-fat and low-calorie foods, skip meals, or eat less, a practice that is more common among those who are concerned about their body weight or eating healthy [12].

Along these lines, dietary restraint (defined as the intention and/or the attempt to restrict caloric intake) [15,16] is another common behavior among this population [17]. However, it appears that dietary restraint does not help with weight control [17,18], on the contrary, this behavior increases the risk for overweight among young populations (adolescents and college students), despite reporting lower energy intake [17]. Importantly, dietary restraint is associated with increased bottom-up reward reactivity to food stimuli, which may help to explain why individuals who attempt to diet are vulnerable to weight gain and binge eating [16]. Furthermore, the evidence suggests that dietary restraint is correlated with lower pleasure and higher craving ratings for high- and low-calorie foods [16].

Regarding other lifestyle behaviors, it has been reported that the level of physical activity in young populations (aged 18-30) has increased in recent years [19,20]. Interestingly, Zurita et al [21] noted that college students who performed high levels of physical activity also reported having a high adherence to the Mediterranean diet. The authors postulate that young people who practice physical activity tend to consume a nutritious diet in order to obtain better results in terms of performance, body image, or wellbeing [21]. Additionally, college students who have greater intrinsic motivation to participate in sports also report healthier habits [22].

Taking into account the aforementioned, it is relevant to study habits related to overweight and obesity (including dietary restraint, alcohol intake, and physical activity) among college students and their association with dietary intake and body mass index (BMI). Especially considering that this stage of life is a critical period in the consolidation of eating habits and behaviors that are important for future health [4,23]. Furthermore, evidence from longitudinal studies has shown that weight and fat mass percentage increase significantly during college years [11,24]. Thus, we aimed to investigate the association between habits related to overweight and obesity with dietary intake, physical activity and BMI among college students. In addition, we aimed to study which was the habit related with overweight and obesity that would predict overweight among college students. In line with previous research and the rationale behind each approach, we hypothesized that healthier habits, that is,

healthier dietary intake, higher levels of physical activity, and lower alcohol intake and dietary restraint would associate with lower BMI.

2. Methods

2.1 Participants and study design

Participants (18 – 26 years) were recruited among undergraduate students at the University of Barcelona (Barcelona, Spain) for a cross-sectional study. Recruitment consisted of an informative talk, explaining details to the students about the research, and inviting them to take part in the study. The exclusion criteria consisted of the unwillingness to participate in the study and/or having any disease that significantly limited the subject's diet (e.g. polyallergies, phenylketonuria, etc.). Also, in the case that a participant provided incomplete information required for the study, he/she was excluded. According to these criteria, a total of 192 participants were eligible to participate in the study and gave their written consent. All the study procedures were conducted according to the general recommendations of the Declaration of Helsinki and were approved by Ethics Committee of the University of Barcelona (IRB00003099).

2.2 Outcome variables

Anthropometric Measurements

Weight and height were asked in a questionnaire as follows: 'What is your current weight? (in kg)' and 'What is your current height? (in cm)'. Self-reported height and weight were used to calculate the BMI as follows: weight (kg) divided by height squared (m^2), kg/m^2. Note that self-reported BMI had a very high agreement with measured BMI values among a similar population [6]. Subsequently, BMI was classified according to the World Health Organization criteria, as follows: "underweight" (<18.5 kg/m^2); "normal-weight" (18.5–24.9 kg/m^2); "overweight" (25.0–29.9 kg/m^2); "obesity" (30.0–34.9 kg/m^2) [25].

Dietary intake

Dietary intake was assessed with a 3-day food register that included two weekdays and one weekend day. A nutritionist taught participants to register the type of food or beverage

(including alcoholic beverages) with brand name if possible, preparation, type of cooking, portion size (in grams or household measures), location of the meal (i.e., home, or restaurant). This information allowed us to estimate the daily intake of energy and nutrients using PCN Pro 1.0 software [26]. According the data from the 3-day food registers, ethanol intake (g/day) was classified as follows: "low" (<5 g/day for women and <10 g/day for men), "moderate" (5-25 g/day for women and 10-50g/day for men) and "high" (>25 g/day for women and >50 g/day for men) [27].

Diet quality was evaluated through the 14-Item Mediterranean Diet Assessment Tool, which has been validated in Spanish population [28]. According to the instructions accompanying the questionnaire, the scores range from 0 – 14, with higher scores indicating greater adherence to the Mediterranean diet. In addition, adherence to the Mediterranean Diet was classified according to the score as follows: "low" (0–5 points), "average" (6–9 points) or "high" (≥ 10 points) [28].

Physical activity

The level of physical activity was evaluated using the short version of the International Physical Activity Questionnaire (IPAQ) in Metabolic Equivalents of Task (MET) – minutes per week [29]. Note that this version of the IPAQ questionnaire has been validated in the Spanish population, in which a good correlation with accelerometer data was obtained [29]. Physical activity levels were classified as follows: "low" (METs <600), "moderate" (METs 600 – 3000), and "vigorous" (METs >3000).

2.3 Exposure variables

Habits Related to Overweight and Obesity Questionnaire

These behaviors were evaluated with the Habits Related to Overweight and Obesity Questionnaire [30,31], which has been validated in Spanish population [30] and has demonstrated reliable psychometric properties in our sample using Cronbach's alpha (α = 0.79). This questionnaire includes 22 questions on life habits, which are answered selecting one of 5 categories that ranged from "Never" to "Each day". The questionnaire contains five

dimensions, and each question is answered using a five level Likert scale that scores ranging from 1 to 5 [30,31]:

i. Caloric intake, which collects information on participants' concern about the calorie content of the diet, as well as the actions they take to control energy intake. This includes: monitoring the calories consumed, taking small portions and waiting a few minutes before taking something they want. Higher scores indicate greater dietary restraint.
ii. Healthy eating, which collects information related to the type of food (and preparations) eaten by a person that is concern about maintaining a healthy diet. Higher scores indicate healthier eating habits.
iii. Physical activity, which collects information related to the habitual or systematic practice of physical exercise. Higher scores indicate more physical activity.
iv. Alcohol consumption, which reflects the frequency with which alcoholic beverages are consumed. Higher scores indicate a low frequency of consumption of high-alcohol beverages (e.g. gin, whisky, rum) or a moderate consumption of low-alcohol beverages (e.g. wine and beer).
v. Eating for psychological well-being, which includes statements that relate food intake to some type of psychological distress (e.g., discouragement, boredom, anxiety, etc.). Higher scores indicate a lower tendency to eat due to psychological distress.

2.4 Covariates

Participant's gender and date of birth (to estimate age) were self-reported through standardized questions.

2.5 Statistical Analyses

Descriptive characteristics are presented for all participants, including mean and standard deviation for continuous variables and proportions for categorical variables. Chronbach's alpha was used to estimate *Habits Related to Overweight and Obesity Questionnaire* internal consistency. The associations between outcome and exposure variables were tested using linear regression models. Analyses were adjusted for gender, age, and physical activity, unless the variable was tested. Subsequently, a discriminant function analysis was performed

to determine which of the 22 questions of *Habits Related to Overweight and Obesity Questionnaire* could reliably classify the subjects according to the BMI categories (underweight, normal-weight, overweight/obesity). We also applied this analysis to evaluate which of the five dimensions (caloric intake, healthy eating, physical activity, alcohol consumption, and eating for psychological well-being) could reliably classify the subjects according to their BMI. Univariate F-tests were then calculated to determine the importance of each independent variable in forming the discriminant functions. Examining the Wilk's Lambda values for each of the predictors revealed how important the independent variable was to the discriminant function, with smaller values representing greater importance. P-values were corrected using the Benjamini–Hochberg method, assuming a false discovery rate of 5%. All analyses were performed with the SPSS statistical computer software, version 25.0 (IBM SPSS Statistics, Armonk, NY, USA). Significance testing was considered when $p < 0.05$.

3. Results

A total of 192 subjects (age 19.7±1.7 years; 75% female) were included in this cross-sectional study (**Table 1**). Overall, the results showed that 83.3% of the participants were normal weight, while 9.4% of the sample was underweight and 7.3% were overweight or obese. Regarding dietary intake, average energy intake was 2024 ±650 kcal, while macronutrient distribution was as follows: 40.5% carbohydrates, 39.7% fat and 18.7% proteins. Additionally, we observed that 86% of the participants were low alcohol drinkers, whereas 12% were moderate and 2% were high alcohol drinkers. About diet quality, we observed that the majority of the participants (66.7%) showed an average adherence to the Mediterranean diet, while 23.4% had a high adherence, and the remaining 9.9% showed a low adherence to this dietary pattern. Furthermore, 55.7% of the sample performed a moderate level of physical activity, while 6.3% and 38% reported either a low or high level of physical activity (respectively).

Regarding health-related behaviors, we observed that the healthy eating dimension and the physical activity dimension were those that presented the highest mean scores (3.5±0.6 points and 3.2±1.3 points, respectively). On the other hand, the caloric intake and the alcohol

246 consumption dimensions were the ones with the lowest scores (2.5±0.8 and 2.6±0.9 points,
247 respectively).
248
249 **Table 1.** Characteristics of the population studied.

Total sample (n)	**192**
Gender, % females	75.0
Age, years	19.7 (1.7)
Anthropometric measures	
Weight, kg	60.8 (9.8)
Height, m	1.6 (0.1)
Body mass index**,** kg/m^2	21.5 (2.8)
Dietary intake	
Energy, kcal/day	2024.3 (650.2)
Carbohydrates, % of total energy/day	40.5 (6.4)
Fat, % of total energy/day	39.7 (6.0)
Protein, % of total energy/day	18.7 (4.7)
Fiber, g/day	21.8 (9.7)
Ethanol, g/day	2.7 (7.1)
Diet quality[1], score	8.0 (2.1)
Physical activity, MET-minutes/week	3099.5 (2119.5)
Habits related to overweight and obesity	
Caloric intake, points	2.5 (0.8)
Healthy eating, points	3.5 (0.6)
Physical activity, points	3.2 (1.3)
Alcohol consumption, points	2.6 (0.9)
Eating for psychological well-being, points	2.9 (1.1)

250 MET, metabolic equivalent of task. [1]The diet quality was evaluated with the 14-Item
251 Mediterranean Diet Assessment Tool. Values are means (standard deviations) for continuous
252 data and percentages (%) for categorical data.
253

As shown in **Table 2**, significant associations were found between the caloric intake dimension and BMI (β= 1.05 kg/m^2 [95% CI: 0.58, 1.51]), energy (β= -312.19 kcal/day [95% CI: -404.55, -219.83]), protein intake (β= 1.77 % of total energy/day [95% CI: 0.98, 2.56]), fat (β= -1.88 % of total energy/day [95% CI: -2.94, -0.83]) and, as well as, with diet quality (β= 0.80 points [95% CI: 0.45, 1.15]). In addition, the healthy eating dimension was significantly associated with energy intake (β= -231.43 kcal/day [95% CI: -367.70, -95.17]) and diet quality (β= 0.96 points [95% CI: 0.47, 1.44]).

Table 2. Associations between the habits related to overweight and obesity and the body mass index (BMI), dietary intake and physical activity.

	Caloric intake [1] β [95% CI]	**Healthy eating [1] β [95% CI]**	**Physical activity [1] β [95% CI]**	**Alcohol consumption [1] β [95% CI]**	**Eating for psychological well-being [1] β [95% CI]**
BMI, kg/m^2	1.05 [0.58, 1.51]***	0.58 [-0.09, 1.24]	0.29 [-0.05, 0.64]	-0.17 [-0.62, 0.28]	0.00 [-0.35, 0.35]
Dietary intake					
Energy, kcal/day	-312.2 [-404.5, -219.8]***	-231.4 [-367.7, -95.2]**	-55.1 [-127.3, 17.2]	-47.4 [-141.2, 46.5]	-28.3 [-102.1, 45.6]
Proteins, % of total energy/day	1.77 [0.98, 2.56]***	1.00 [-0.13, 2.13]	0.48 [-0.10, 1.07]	-0.18 [-0.94, 0.59]	0.25 [-0.35, 0.85]
Fat, % of total energy/day	-1.88 [-2.94, -0.83]**	-0.95 [-2.43, 0.54]	-0.25 [-1.02, 0.52]	-0.08 [-1.08, 0.91]	-0.26 [-1.04, 0.52]
Carbohydrates, % of total energy/day	-0.39 [-1.55, 0.77]	0.25 [-1.33, 1.83]	-0.37 [-1.18, 0.45]	-0.31 [-1.37, 0.75]	-0.29 [-1.12, 0.54]
Ethanol, g/day	0.74 [-0.55, 2.04]	-0.93 [-2.69, 0.85]	-0.18 [-1.10, 0.74]	1.81 [0.65, 2.97]**	0.28 [-0.66, 1.21]
Fiber g/day	-0.80 [-2.51, 0.90]	2.30 [-0.01, 4.61]	0.82 [-0.38, 2.02]	-0.05 [-1.61, 1.51]	0.14 [-1.09, 1.37]

Diet quality[2], points	0.80 [0.45, 1.15]***	0.96 [0.47, 1.44]***	0.41 [0.16, 0.66]**	0.04 [-0.29, 0.38]	0.07 [-0.20, 0.33]
Physical activity, METs-minutes/week	43.5 [-337.8, 424.8]	-263.4 [-781.4, 254.5]	727.2 [507.3, 947.1]***	-185.9 [-533.0, 161.2]	-168.4 [-441.0, 104.0]

CI, confidence interval. [1]Dimensions were evaluated with the habits related to overweight and obesity questionnaire. [2]Diet quality was evaluated with the 14-Item Mediterranean Diet Assessment Tool. Data was analyzed using linear regression models to test associations between the 5 dimensions of the habits related to overweight and obesity questionnaire and BMI, dietary intake and physical activity. Analyses were adjusted for age, gender and physical activity, unless the variable was tested. P-values were corrected using the Benjamini–Hochberg method, assuming a false discovery rate of 5%. The table shows the unstandardized coefficient (β), 95% CI and p-value associated with each predictor variable. Significant p-values * <0.05; ** <0.01; *** <0.001.

The physical activity dimension was significantly associated with diet quality (β= 0.41 points [95% CI: 0.16, 0.66]) and, as expected, it was also related with the level of physical activity (β= 727.22 METs/week [95% CI: 507.36, 947.07]). Regarding the dimension of alcohol consumption, our data showed that it was significantly associated with a higher ethanol intake (β= 1.81 g/day [95% CI: 0.65, 2.97]). However, we did not find significant associations between the eating for psychological well-being dimension and the outcome variables.

Finally, we conducted a secondary analysis using a discriminant model to investigate which habit related to overweight and obesity would predict overweight among college students. The results showed that the question "I am concerned about the calories I take at the end of the day" was the only one which could reliably classify the BMI of 29.7% of the subjects. Within the dimensions, we observed that the caloric intake dimension was the only one that could classify 32.8% of the subjects into 3 BMI groups: underweight, normal, and overweight/obesity.

4. Discussion

The main finding of this study was that greater dietary restraint (expressed as “caloric intake dimension”) was associated with higher BMI, while it was related to lower calorie and fat intake. These findings are built on existing research showing that regular calorie monitoring is related to eating concern and dietary restraint among college students [32], although it remains uncertain whether these behaviors are linked with BMI [32,33]. Note that in our study, greater dietary restraint was associated with higher adherence to the Mediterranean diet, lower energy and fat intake (approximately -312.19 kcal/day and -1.88 % from total energy/day), but higher BMI. In agreement with these findings, Martín-García et al. [34] observed that children and adolescents who reported greater cognitive restraint also had higher BMI values, and therefore pointed out the *restraint theory* [35,36]. This theory supports that chronic food restriction could alternate with episodes of overeating, which could lead to weight gain, and that this increase in weight could also lead to caloric restriction, becoming a vicious cycle [35,36]. Another possible reason according Racine [16] is that individuals with high cognitive restraint choose more low-calorie or “healthy” foods, but these foods are consumed in greater serving sizes, and total caloric intake remains unchanged.

Along these lines, a cross-sectional study that evaluated self-reported weight-loss strategies among Australian adults (> 18 years), pointed out that following low-calorie and low-fat diets were two of the most frequent strategies used to lose weight, even among individuals who were normal-weight [37]. The authors noted that while limiting dietary fat may result in weight loss, this behavior could also lead to an overconsumption of low-fat products, as consumers perceive these products to be healthier [37]. The latter could be related with our observation that greater dietary restraint was associated with low energy and fat intake, but higher BMI (~1.05 kg/m^2). Consistent with our findings, a recent study showed that adolescents and young adults (14–24 years; n=84) with greater dietary restraint were more likely to be overweight, despite reporting lower energy intake [17]. It is important to note that the results obtained from the discriminant analysis demonstrated that the caloric intake dimension and the question "I am concerned about the calories I take at the end of the day" were the only ones that could classify subjects into the 3 BMI categories (underweight, normal-weight and overweight/obesity).

Furthermore, the results revealed that among college students, greater dietary restraint was associated with a higher protein intake, which could be another weight loss strategy. According to Moon et al. [38], the mechanism by which a high-protein diet induces weight loss involves an increase in satiety and energy expenditure, concluding that it is a safe method for losing weight while preserving fat-free mass [38].

Our results also show that a greater concern about healthy eating (expressed as “healthy eating dimension”) was associated with lower energy intake (approximately -231.4 kcal/day) and a greater adherence to the Mediterranean diet (~0.96 points). This is in line with a Finnish study that showed that undergraduate students, who considered healthy eating important, also showed greater adherence to dietary guidelines [4]. The authors postulated these results were encouraging for public health, as they suggested that *“young adults put into action (adherence to dietary guidelines) what they believed as important (eating healthy)”* [4]. Consistently, Sogari et al. [2] reported that the perceived benefits of healthy eating also influenced the intention to eat better and that it was more easily achieved among students who planned their meals. The study authors also reported that university characteristics,

331 including living arrangements or academic schedules, also influenced the relationships
332 between college students and their eating behaviors. Thus, they suggested that these factors
333 should be taken into account when designing nutritional intervention programs [2].
334
335 In the present study, we also demonstrate that a greater practice of physical exercise
336 (expressed as "physical activity dimension") was associated with a higher adherence to the
337 Mediterranean diet and as expected, a higher level of physical activity (~727.2 METs/week).
338 These results are in line with the evidence presented by other studies, where higher levels of
339 physical activity were related to a greater adherence to Mediterranean diet [21,22,39]. Note
340 that young people who practice physical activity regularly show a greater tendency to
341 consume a nutritious diet, probably in order to obtain greater results in terms of performance,
342 body image, and wellbeing [21]. In addition, several authors highlight that the promotion of
343 physical activity is one of the fundamental pillars of health promotion and disease prevention
344 among young adults [20,40,41]. Furthermore, the regular practice of physical activity among
345 youngsters is related to levels of happiness [19].
346
347 At this point, an interesting concept to promote among young adults, is the Mediterranean
348 lifestyle, that could be described as a healthy way of living focused daily physical activity
349 and high adherence to the Mediterranean diet [40]. This lifestyle has shown many benefits,
350 such as protecting against weight gain and improved physical well-being by mitigating the
351 risk of cardiovascular events (even in the presence of overweight/obesity) and all-cause
352 mortality adults (>18 years)[40].
353
354 The association between the frequency of alcohol consumption (expressed as "alcohol
355 consumption dimension") and ethanol intake could be explained by the fact that the
356 Mediterranean Diet includes as part of its recommendations moderate alcohol consumption,
357 especially from wine [27,42]. Note that among the sample studied, the average alcohol intake
358 was 2.7±7.1 g/day and most of the participants were classified as low alcohol consumers.
359 Furthermore, Scholz et al [27] observed that among Spanish college students, those who
360 exclusively consumed beer and/or wine had a higher adherence to the Mediterranean diet
361 compared to non-drinkers. Nevertheless, care must be taken when interpreting these findings,

as the balance between potential harms and benefits of moderate alcohol consumption is a complex matter and no consistent recommendations exist yet [27]. In addition, young adults are more likely to get drunk, among other things, it is because alcohol intake helps them to increase their body confidence [12].

The limitations found in our study are related to the cross-sectional design, that does not allow to define causal relationships. Furthermore, we acknowledge that our sample was composed mostly of women, which is not representative of the entire population. Another limitation is that food intake was assessed using 3-day food record, which are prone to underreport food intake [43].

5. Conclusions

In conclusion, college students who showed a greater dietary restraint were those who had the highest BMI, despite having the lowest energy and fat intakes. In addition, we showed that young adults with greater concern for healthy eating and a greater practice of physical exercise showed greater adherence to the Mediterranean diet. This information could be useful in promoting healthy behaviors among college students. Starting with promoting the Mediterranean lifestyle, which includes a high adherence to the Mediterranean diet and the daily practice of physical activity. Moreover, we showed that the results obtained with the Habits Related to Overweight and Obesity Questionnaire showed convergence with those of the Mediterranean assessment tool and IPAQ questionnaire, since the dimensions of healthy eating and physical activity were significantly associated with the Mediterranean diet assessment tool and IPAQ questionnaire.

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Conflict of Interests

The authors declare no conflict of interest.

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