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Association between Body Mass Index and the Use of Digital Platforms to Record Food Intake: Cross-Sectional Analysis

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Featured Application: This study informs the healthcare workers implicated in the treatment of obesity about how the use of digital platforms to record food intake is related to the body mass index in a sample of a general population with high internet literacy. These data can be applied to guide the appropriate use of these resources by the population and thus improve the repercussions of their utilization on the user's health.

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Abstract: An inadequate diet has been shown to be a cause of obesity. Nowadays, digital resources are replacing traditional methods of recording food consumption. Thus, the objective of this study was to analyze a sample of United States of America (USA) residents to determine if the usage of any meal tracker platform to record food intake was related to an improved body mass index (BMI). An analytical cross-sectional study that included 896 subjects with an Instagram account who enrolled to participate in an anonymous online survey was performed. Any meal tracker platform used to record food intake over the last month was employed by 34.2% of the sample. A total of 85.3% of the participants who had tracked their food intake were women ($p < 0.001$), and 33.3% ($p = 0.018$) had a doctorate degree. Participants who used any meal tracker platform also had higher BMIs (median: 24.9 (Q1: 22.7–Q3: 27.9), $p < 0.001$), invested more hours a week on Instagram looking over nutrition or physical activity (median: 2.0 (Q1: 1.0–Q3: 4.0), $p = 0.028$) and performed more minutes per week of strong physical activity (median: 240.0 (Q1: 135.0–Q3: 450.0), $p = 0.007$). Conclusions: USA residents with an Instagram account who had been using any meal tracker platform to record food intake were predominantly highly educated women. They had higher BMIs despite the fact they were engaged in stronger exercise and invested more hours a week on Instagram looking over nutrition or physical activity.

Keywords: diet records; eHealth; body mass index; internet of things; social media

1. Introduction

In 2016, the prevalence of being overweight in the adult world population was 39% in persons over 18 years old (39% of men and 40% of women). The prevalence of obesity was 13% (11% of men and 15% of women). The prevalence of obesity throughout the world almost tripled between 1975 and 2016 [1]. The prevalence of obesity has been reported at about 20% in the United States of America [2]. Being overweight or obese is related to overall mortality [3] and particular causes of death, including cardiovascular and respiratory diseases and cancer [3]. Being overweight or obese augments the risk of numerous chronic diseases, especially cardiovascular diseases, type 2 diabetes mellitus, and some cancers [4].

Inadequate dietary habits have been shown to cause obesity prevalence among the population [5]. In the age of digital technology, different ways of trying to improve health with innovative technologies have been developed [6]. Health information via social media, with nutrition [7] and fitness counseling [8], wearable devices to track physical activity [9], and applications to record food intake—or even more specific platforms for different types of users, such as patients with food allergies [10], older adults [11] or young children [12]—are frequently used by the population. Thus, nowadays, digital applications or platforms are replacing traditional ways of recording our food intake, such as written food diaries or food frequency questionnaires [13,14].

Some of these applications have been developed for different populations, such as the Irish [15], British [16–18], German [19,20], French [21], Swedish [22], Italian [23], Arabian [24], Canadian [25], Australian [26] or United States of America [27] populations, with the aim of addressing the epidemiological challenges regarding health and weight loss. On the contrary, a large number of smartphone applications have been created by private institutions, with a mainly commercial purpose [28]. Usually, they have not been validated (only around 0.8% of the apps registering food intake have been scientifically evaluated [29]); they have not involved nutrition professionals during their development (only around 0.05% have been created with identifiable professional advice [30]) [31], and they have not been adapted to the different cultural food habits [32]. These apps are developed to be used by the general population, with the main objective of weight management [31]. They have been shown to report acceptable energy intake and fat proportions [33], despite micronutrients being predominantly underrated [33]. For example, MyFitnessPal has been shown to be accurate for calculating total energy intake and fiber [34] but underrated sodium intake [35]. The accuracy of the apps in registering the consumption of saturated and polyunsaturated fatty acids, a relevant aspect of cardiovascular health, has been evaluated as poor [36]. It has been stated that the greater source of error might reside in the estimation of the portion size [37], in the use of non-specific food composition data for each country, and in the modification of a food list by the user [38].

Widely used applications, such as MyFitnessPal, Lose It!, or FatSecret [31], are designed to capture dietary data and even to provide personalized nutritional advice, and the majority are used without professional support [39]. The quality of the information provided by some of these apps (Yazi, FeelEat, and Bonne App) has been evaluated by dieticians and nutritionists, showing high-quality scores, although other widely used applications, such as Lose It!, obtained worse marks [40]. Specificity of the content has been shown as a deficit topic in general, although FeelEat has also been evaluated as being correct in this issue [40]. The experiences that favor the use of apps to track food consumption have been elucidated. Between them, easier and quicker food data annotation, with respect to more conventional methods, the provision of goals, diet recommendations, and the indications of progress [39], are noticeable. When considering personal factors favoring the use of these apps, privacy has been identified as the most remarkable [39]. On the other hand, it has also been stated that the user can become addicted and obsessed [39]. For example, it has been shown that people with high signs of eating disorders use MyFitnessPal more [41]. Dietary tracking with MyFitnessPal has also been linked to an exacerbation of body concern in college women with body dissatisfaction and to changes in feelings (both positive and negative), dietary intake and even increases in weight [42]. Users are worried about the possibility of becoming obsessed, especially those with a poor body image [42]. In young adults, dietary tracking with apps has been associated with a greater presence of irregular weight control behaviors, such as fasting or purging [43].

In summary, the way in which the use of these applications, without professional intervention, influences the maintenance of a healthy weight has not been widely studied, despite the huge number of apps available on the market (it has been reported that there are around 30,000 marketable mobile apps dedicated to a selection of food and/or physical activity) [31]. In order to enhance the evidence about the effects of the use of these apps on the population has been recommended [40]. Thus, the objective of this manuscript is to present an analytical cross-sectional study of United States of America (USA) residents who have an Instagram account and to determine if the usage of any meal tracker platform to record food consumption was related to an improved body mass index (BMI). We hypothesized that using any meal tracker platform to record food intake would improve healthy weight maintenance.

2. Materials and Methods

2.1. Study Design

The study was a cross-sectional analysis and included USA residents enrolled to contribute to an anonymous online survey.

2.2. Setting

The connecting link to the research was sent via email to actual or graduated students from the University of Mary Hardin Baylor, Oakland University, the University of Kentucky, and Queens University of Charlotte. The survey link was also expanded via Facebook and Instagram. The distribution of the link was achieved with a cascade effect. The survey was hosted on the Survey Monkey platform. An opportunity sampling method was performed.

2.3. Participants

In order to estimate the sample size, an infinite population was assumed. The expected proportion used was 71%. Instagram was used in 2021 by around 71% of the United States of America adults [44]. The GRANMO calculator "https://www.imim.es/ofertadeserveis/software-public/granmo/ (accessed on 2 September 2019)" was utilized to compute the sample size [45], with a 0.95 confidence level and desired precision of +/− 3.5 percent units in the population estimation option. A minimal number of 646 participants was obtained.

Finally, the number of registered surveys was 896, taking into consideration the possibility of doubtful or incomplete answers in some of the registers.

The participants were eligible for inclusion if they were older than 18 years and they had an Instagram account. The consideration of users' internet literacy was considered a relevant factor in influencing the capacity of users to track their food intake digitally [46]. The selection of a sample connected to Instagram might favor its homogeneity regarding the user profile according to their literacy level or technological skills [47].

2.4. Ethical Considerations

The University of Zaragoza, via the Academic Commission of the Doctoral Program in Health and Sports Sciences (protocol code: "Impact of Instagram on the lifestyle and physical activity in the United States of America" 2 July 2019), approved the study, which observed the ethical stipulations of the Declaration of Helsinki [48]. The survey was conducted in a way that minimizes possible harm to the environment; it was anonymous, and the information was to be destroyed after the study was completed.

The study did not register questions regarding religion, political views, race, or other aspects that could infringe on research ethics. Before starting the completion of the survey, the subjects dispensed volunteer informed consent.

2.5. Data Sources

In the survey, the participants were questioned about the following:

- Gender: man/woman/others.
- Age, grouped in generations: Generation Z (born 1997–2012); Millennials (born 1981–1996); Generation X (born 1965–1980); Boomers (born 1946–1964) [49].
- Height, measured in feet and inches, and weight, measured in pounds. BMI was determined: BMI = 703 $\times$ weight (pounds)/[height (inches)]^2. BMI is considered an index with very high specificity (97%) to detect obesity [50]. Self-reported weight and height online have shown to be a valid method, with moderate to good agreement between measured anthropometric data and those self-reported [51].

- Do you smoke? Yes/No/Occasionally. It has been stated that traditional epidemiological risk factors can be collected with equivalent or superior reliability online compared with conventional methods [52].
- Highest academic degree attained, classified by a doctorate degree; master's degree; bachelor's degree; associate degree; trade/technical/vocational training; some college credit, no degree; high school graduate or the equivalent.
- How long the participants have been regularly on Instagram, classified as less than 1 year, between 1–2.5 years, and more than 2.5 years.
- How many hours per week on Instagram looking over nutrition or physical activity.
- The physical activity executed by the participants was registered with the short form "last 7 days" of the International Physical Activity Questionnaire (IPAQ) [53]. It was self-administered, and vigorous physical activity (minutes per week), moderate physical activity (minutes per week), time spent walking (minutes per week), and time spent sitting (hours per day) were recorded. This questionnaire is considered reliable and valid for noting physical activity information [54].

In order to test the influence of the usage of any meal tracker platform to record food intake regarding BMIs, the participants answered about the usage over the last month of any meal tracker platforms to record their food intake. The answer was classified as: No/Yes.

2.6. Statistical Analyses

Gender, generation, smoking habits, academic degree, and time spent on Instagram were described with percentages in each category. BMI, hours per week on Instagram looking over nutrition or physical activity, vigorous physical activity, moderate physical activity, time spent walking, and time spent sitting were described with the median, 25th percentile (Q1) and 75th percentile (Q3) because they were not normally distributed according to the Kolmogorov–Smirnov test.

A chi-squared test was selected to study the relations of the usage, over the last month, of any meal tracker platforms to record food intake with gender, generation, smoking habits, highest academic degree attained, and time spent on Instagram (the maximum likelihood ratio chi-squared test was used when expected frequencies in some cells were less than 5). The Mann–Whitney U test was adopted to compare BMIs, hours per week spent on Instagram looking over nutrition or physical activity, vigorous physical activity, moderate physical activity, time spent walking, and time spent sitting between the participants who did not use any meal tracker platforms to record their food intake over the last month with those who did. The statistical significance was established at a $p < 0.05$.

SPSS 25.0 for Mac was used for the calculations.

3. Results

Of the 896 who participated, 78.7% were women, 20.6% were men, and 0.7% classified themselves as others. Regarding the generations, 11.5% belonged to Generation Z, 75.6% belonged to the Millennials, 11.4% belonged to Generation X, and 1.6% belonged to the Boomers. A total of 93.5% of the sample did not smoke, 2.3% used to smoke, and 4.1% used to smoke occasionally. Regarding the academic degree attained, 3.7% were high school graduates, 6.1% had some college credit, 0.6% had technical training, 3.2% had an associate degree, 43.2% had a bachelor's degree, 15.1% possessed a master's degree, and 28.1% possessed a doctorate. The majority of the participants (52.3%) regularly consulted Instagram for less than one year, 17.8% regularly consulted Instagram for between 1 and 2.5 years, and 29.9% had more than 2.5 years. They spent a median of 2 h per week (Q1: 1–Q3: 3) on Instagram looking over nutrition or physical activity. In relation to BMI, the median was 24.0 (Q1: 21.8–Q3: 27.2). The median of the total minutes per week performing vigorous physical activity was 240.0 (Q1: 120.0–Q3: 360.0), and performing moderate physical activity was 180.0 (Q1: 90.0–Q3: 360.0). The median of the minutes per week spent walking was 360.0 (Q1: 140.0–Q3: 840.0), and the median of the time spent sitting (hours per day) was 5.0 (Q1: 4.0–Q3: 8.0).

Any meal tracker platform to record food intake over the last month was used by 34.2% (*n* = 306) of the sample (Table 1). The associations between gender, generation, smoking habits, academic degree, time on Instagram, BMI, hours per week on Instagram looking over nutrition or physical activity, vigorous physical activity, moderate physical activity, time spent walking, and time spent sitting, and the variable usage of any meal tracker platform to record food intake can be seen in Table 1. Gender, academic degree, BMI, hours per week on Instagram looking over nutrition or physical activity, and minutes per week of vigorous physical activity showed a significant dependency on the usage of any meal tracker platform to record food intake. The percentage of women and the percentage of participants with a doctorate were significantly higher in the group that used any meal tracker platform than in the group that did not. Of the participants who had tracked their food intake, 85.3% were women, and 33.3% had a doctorate. The participants who used any meal tracker platform had higher BMIs, invested more hours a week on Instagram looking over nutrition or physical activity, and performed more vigorous physical activity. They had a median BMI of 24.9, invested a median of 2 h a week on Instagram looking over nutrition or physical activity, and performed a median of 240.0 min a week of vigorous exercise.

Table 1. Comparative analysis of the participants depending on the usage of any meal tracker platform to record food intake over the last month.

	Usage of Any Meal Tracker Platform to Record Food Intake over the Last Month		
	No	**Yes**	***p* Value**
Gender (*n* = 896)			
Man	23.7%	14.7%	<0.001
Woman	75.3%	85.3%	
Other	1.0%	0.0%	
Generation (*n* = 896)			
Generation Z (born 1997–2012)	11.0%	12.4%	0.057
Millennials (born 1981–1996)	73.9%	78.8%	
Generation X (born 1965–1980)	13.2%	7.8%	
Boomers (born 1946–1964)	1.9%	1.0%	
Smoke (*n* = 896)			
No	92.9%	94.8%	0.548
Yes	2.5%	2.0%	
Occasionally	4.6%	3.2%	
Degree (*n* = 896)			
High school graduate. diploma or the equivalent	4.6%	2.0%	0.018
Some college credit. No degree	6.9%	4.6%	
Trade/technical/vocational training	0.8%	0.0%	
Associate degree	3.6%	2.6%	
Bachelor's degree	43.4%	42.8%	
Master's degree	15.3%	14.7%	
Doctorate Degree	25.4%	33.3%	

Table 1. *Cont.*

	Usage of Any Meal Tracker Platform to Record Food Intake over the Last Month		
Time on Instagram (*n* = 792)			
Less than 1 year	50.8%	55.1%	0.455
Between 1–2.5 years	18.0%	17.5%	
More than 2.5 years	31.2%	27.4%	
	Median (Q1–Q3)	**Median (Q1–Q3)**	
Body Mass Index (*n* = 896)	23.6 (21.5–26.7)	24.9 (22.7–27.9)	<0.001
Hours per week on Instagram looking over nutrition or physical activity (*n* = 685)	2.0 (1.0–3.0)	2.0 (1.0–4.0)	0.028
Vigorous physical activity (min per week) (*n* = 765)	232.5 (120.0–360.0)	240.0 (135.0–450.0)	0.007
Moderate physical activity (min per week) (*n* = 741)	180.0 (90.0–360.0)	180.0 (90.0–360.0)	0.692
Time spent walking (min per week) (*n* = 844)	420.0 (140.0–840.0)	315.0 (122.5–840.0)	0.377
Time spent sitting (hours per day) (*n* = 859)	5.0 (4.0–8.0)	5.0 (4.0–8.0)	0.415

4. Discussion

This study has examined the relationship between the usage of any meal tracker platform to record food intake and gender, generation, smoking habits, academic degree, time on Instagram, BMI, hours per week on Instagram looking over nutrition or physical activity, and physical activity in USA residents that possessed an Instagram account. It was shown that a superior percentage of women and participants with a doctorate tracked their food intake. Moreover, those participants who tracked their food intake had higher BMIs, invested more hours a week on Instagram looking over nutrition or physical activity, and performed more vigorous physical activity. Thus, our outcomes suggest that using any meal tracker platform to record food intake over the last month would not lead to a lower BMI.

Any meal tracker platform to record food intake over the last month was used by 34.2% of the sample. A total of 85.3% of the participants who had tracked their food intake were women ($p < 0.001$) and 33.3% ($p = 0.018$) had a doctorate. It has been previously shown that women and more educated participants are likely to be better respondents to online dietary intake measurements [55], which is according to our results. Women college students have manifested as those who track calories more so than men [56,57], and highly educated citizens were revealed to use more mobile health applications [58]. Women were shown to be better respondents to the online surveys requesting data about their health-based app use [59]. More women than men have been identified as users of apps from healthy lifestyle websites for nutrition information, weight loss, and physical activity [59].

The prevalence of smoking habits in adults in the USA was determined to be 18% in 2012, and it continues to decrease [60]. In this study, the vast majority of the sample did not smoke, and there were no differences between the group that recorded their food consumption and the one that did not; thus, we can eliminate tobacco as a factor that could influence BMIs [61].

Participants who used any meal tracker platform had higher BMIs (median: 24.9 (Q1: 22.7–Q3: 27.9), $p < 0.001$), despite being engaged in more vigorous physical activity (median: 240.0 (Q1: 135.0–Q3: 450.0), $p = 0.007$) and complying with the recommendations on the amount of vigorous physical activity for health benefits from the World Health Organization (more than 75 min per week) [62]. Although it has been postulated that exercise is one of the keys to maintaining a healthy weight, the amount and type of physical activity that should be performed to achieve improvements is still subject to discussion [63]. A recent review showed that exercise protocols based on high-intensity interval training with a slow volume that require less time, however, favored better cardiorespiratory adaptations than continuous moderate physical activity, yet they did not provoke changes in the body's composition in normal, overweight, or obese adults [63]. However, it has also been shown that vigorous physical activity may be more beneficial than moderate physical activity in reducing waist circumference and visceral adiposity; however, this was observed in adults who are overweight or obese [64].

Thus, the tracking of food intake in our study is not related to a more healthy weight because, according to the BMI categories [65], participants who tracked their food intake were almost overweight (BMI between 25 and 29.9), while those participants who did not (median: 23.6 (Q1: 21.5–Q3: 26.7)), stayed not-so borderline of the normal BMI category (between 18.5 and 24.9). This is in agreement with the results of a recent review, which found that the effectiveness of multicomponent technologically mediated interventions for weight management in obesity showed promising results; however, the isolated use of an app received presumably less positive outcomes [66]. A recent review of intervention studies using smartphone apps has analyzed the effects on anthropometric, metabolic, and dietary outcomes. It has highlighted weight loss in adults being overweight and obese for 3 and 12 months, although with minimal long-term effectiveness [67]. A recent study on overweight or obese adults, who were advised to self-monitor their dietary intake for 8 weeks with an app, has found that if the frequency of self-monitoring was consistent, weight loss could be achieved in the short term [68]. Another recent study has shown that using tailored weight and calorie goals provided by professionals to track a person's food intake with a mobile app can produce clinically significant weight loss [69]. Thus, by only using the isolated online tracking of food intake, the maintenance of a healthy weight does not seem to be effective, though, previously, it has been shown that electronic dietary records were better than traditional methods for BMI reduction [49]. However, if there is professional support, the results improve. Anteriorly, it has been stated that in order to progress to healthy dietary behaviors, having simple knowledge of the facts is not enough. It would be necessary to develop favorable convictions towards alimentation [70] and have the professional support of a dietitian's skills to obtain behavioral change and sustainable weight reduction [71]. In fact, app users have declared that having professional support for using the apps may be interesting [39]. It has been demonstrated that a combination of care with digital apps-based tools and support by health professionals is effective for healthy weight achievement [72]. The factors included in these interventions, which conditioned the best results in weight management, were as follows: self-management, particularly in the first phases of the interventions; early education in nutrition and diet; and totally online support messages from health professionals [72].

Participants who used meal tracker platforms of any type not only had higher BMIs but also invested more hours a week on Instagram when looking over nutrition or physical activity (median: 2.0 (Q1: 1.0–Q3: 4.0), $p = 0.028$). The time of social media consumption has been shown to be correlated to the augmented sitting time on non-business days [73], and a higher BMI has been associated with more time spent sitting [74].

It might be supposed, however, that these almost-overweight participants sought help via technology or apps to track their food intake, and information on the web to try to achieve a healthier weight. It seems that they were aware of the benefits of a healthy weight and turned to new technologies in search of support to achieve it. This is a fact that might be confronted by health professionals, given that it might show that health services are not offering all the necessary support to educate populations in healthy nutritional behavior or that people even prefer not to consult health professionals because they might feel stigmatized [75]. It has been shown that the most habitual origins of stigma in overweight and obese adults come from doctors, classmates, store clerks, companions and fellow workers, and also from younger teachers and nurses; however, the increased frequency of stigma is not associated with BMI [75]. Therefore, it is relevant that health professionals consider improving their communication skills, avoid inappropriate comments and show comprehension and empathy [75] to favor those people concerned about their weight who turn to professionals for help.

Limitations

This study is subject to some limitations. It is based on a cross-sectional study method; thus, any causality can be referred to as relations with significant results. However, due to the scant bibliography that exists so far on the subject, the results found may be a good starting point for the future development of prospective longitudinal studies to clarify the repercussions of populations' generalized use of meal-tracking platforms. Previous studies have shown that during weight loss interventions, to guaranty ad-herence, to track the food intake diary, at least in two occasions must be achieved [76]. In our study, the number of times or the frequency at which the participants tracked their food intake was not registered. The fact that the use of a meal tracker platform is not related to a better BMI might be related to an inconstant adherence to the tracking habit in our study. Participants were questioned only about their usage of the meal-tracking platform over the last month to facilitate a concrete response and not provoke an inferred response because the event would not be concretely recalled [77]; this might also be considered a short period where the monitoring of changes in BMI can occur. Millennials are the predominant generation represented in the study. Previously, it has been stated that older adults are less prone to adopt the use of digital health technologies [78], but this fact might compromise the representativeness of our sample to other populations with a more balanced representation of the different generations. The sampled participants have a high and homogeneous internet literacy. Expanding the survey link through universities might have conditioned the access to the survey link to highly educated individuals. Thus, the results might be generalizable only to populations with similar characteristics.

5. Conclusions

United States of America residents with an Instagram account who had used any meal tracker platform to record their food intake over the last month were predominantly highly educated women, contemplating that the primary route of expansion of the survey link was through universities and that the predominant generation represented in the sample were Millennials. They had higher BMIs, despite the fact they were engaged in more vigorous exercise and invested more hours a week on Instagram looking over nutrition or physical activity, which might show that these participants rely on new technologies in search of their optimal weight.

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