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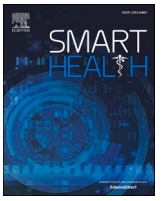

Digital native students using nutritional apps: are they more adherent to a mediterranean diet model? Results from the good APPetite survey

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ABSTRACT

Reading and understanding food labels are crucial steps in healthy dietary choices. Nutrition-related applications (n-apps) have increased in the recent years and the aim of this study was to assess the use and the perception of n-apps among a population of university students, also investigating the attitude and relationship with reading food labels and adherence to the Mediterranean diet (Medi-Lite score).

In 2023, 316 students, mainly attending the courses of Medicine, Pharmacy and Dietetics at the University of Brescia, Italy, completed an anonymous and specifically designed survey. 33.9% of the students stated that they use or have used n-apps. The most used apps were Yuka, MyFitnessPal, Fat Secret and Yazio, especially for the ease of use, speed, nutritional values estimation and barcode reading. 53.2% and 53.5% of the students declared to be food information and nutrition label readers respectively and the Medi-Lite mean value was 9.98 ± 2.46. N-app-users were significantly more attentive to food information and nutrition label than app not-users (both $p < 0.0001$) and recorded a Medi-Lite score significantly higher ($p = 0.0131$).

The present study found for the first time an extensive correlation between the use of n-apps, the food labels awareness and healthy eating habits in a digitally native population.

1. Introduction

Choosing the right foods when shopping is an essential requirement for achieving and maintaining good health. Labels on packaged foods play an important role in influencing consumer behavior, and individuals who frequently read nutrition labels tend to engage in healthier dietary practices than those who do not read labels (Graham & Laska, 2012; Ni Mhurchu et al., 2018; Tezçi & Montanari, 2023). Nutrition labelling includes mandatory nutrient information and supplementary data that can be found on the back of food packages or on the front-of-pack (FOPL). Reading, understanding and correctly interpreting nutrition information could represent crucial steps for consumers in making healthy food choices. To overcome barriers and misinterpretations a first step is to make the nutritional information easy to find, read and understand; in the European Union (EU), since 2011, a Regulation in food labelling was approved, in order to uniform food labelling in the European territory and to minimize the risk of misunderstanding through misleading messages (EU Regulation, 2011/2011). In recent years EU interest in food labelling is aimed at finding a FOPL, with an immediate impact on consumers, such as a traffic light label system, the use of health logos, nutrition claims and green check marks:

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the difficult mediation between practicality, knowledge and benefits, while respecting the county's food culture, has not yet led to a shared system at European level (World Health Organization - WHO; Nutrition labelling).

Digital technologies, especially regarding the use of apps, have considerably evolved in the recent years, introducing applications for several everyday life aspects. The development and use of digital systems also in health promotion, the so-called mobile health (mHealth), have been exponential and steady growth in last few years. Currently, the number of people in the world who use a mobile phone is 4.9 billion, with a forecast growth to 6.4 billion by 2029 (Statista, 2024). In Italy, the number of people using a smartphone has grown rapidly, from around 20 million in 2018 to more than 35 million in 2023; the number of monthly active smartphone users in Italy is projected to reach more than 41 million individuals (Statista, 2024). Through smartphone and apps nowadays it is possible to perform many different tasks with a handful of taps on the screen: checking daily news, the weather forecast, buying goods, communicating through messages, pictures or videos, engaging relationships, playing different game, and so on. Digital native, a term first coined in 2001 by the US author Marc Prensky to describe young people, born after 1980, who have been surrounded by mobile phones and other digital devices from a very early age, are the segment of the population increasingly involved in the purchase and use of smartphones and apps (Prensky, 2001; Reid et al., 2023).

The widespread of technology may help to improve some aspects of education, to rise risk awareness and to improve lifestyle behavior, particularly among young people, who are generally more engaged in technology devise use (McDermott et al., 2023). Moreover, through the use of smartphone and several applications (apps), subjects can actively participate in health promotion: more informed choices can foster greater adherence to both prevention and treatment pathways (Covolo et al., 2017). Among the available health and wellness apps, those dedicated to nutritional information and weight management are the most widely used (Samoggia et al., 2020). Through Google Play or the App Store it is possible to download free apps for calories and nutrients' counting or for general diet control, apps to promote health and wellness, to control weight or to follow a specific nutritional plan, even with included cooking recipes (Mistura et al., 2021).

Apps make it easier to approach healthier eating habits and could be a useful tool to bring nutritional advice into real life, including quick choices while shopping. Food purchasing represents a critical phase in the decision-making process and in the adoption of healthier eating habits, and the use of nutrition-information app decreases the perception of barriers between food producers and consumers (Samoggia et al., 2020). Even barcode scanners, incorporated in several nutritional apps, enables nutritional information from packaged foods and raise awareness of consumer practices.

University students represent a population in which developing routines are being established, including planning and consumption of meals. Adopting healthy eating habits during this transitional period, might been of importance in developing correct diet practice in adulthood and in reducing the risk for chronic diseases later in life. Even in this population, habitual reading of food labels correlates with healthier food choices (Buyuktuncer et al., 2018; Graham & Laska, 2012). Integrating the mHealth technology into health promotion efforts for this population of digital natives may be particularly beneficial (Romano et al., 2017).

The present study aims to investigate, among students attending the University of Brescia, a city in the North of Italy, the use of specific applications for nutritional assessment (n-apps); we also aim to explore the motivations that drove users to download apps, the features they sought and the aspects that led them to uninstall the app from their smartphone. At the same time, we intend to assess awareness of the qualitative and quantitative aspects of their diet, through the reading of nutritional information and food labels and, finally, the adherence of this population to the Mediterranean Diet (Med Diet). Identifying any relationship between the use of n-apps and the other variables investigated, would allow us to understand whether the use of apps also influences the eating behavior of university students.

2. Material and methods

2.1. Recruitment

The present study was conducted at the University of Brescia, Italy, among students attending the degree courses of Medicine and Surgery (MS), Pharmacy (Pharm), Dietetics (Diet), Exercise and Sport Sciences (ESS), Sustainable Agricultural Systems (SAS) and Environment and Workplace Prevention Techniques (EWPT) from March 15 to April 30, 2023. The administration of questionnaire took place during class hours, thanks to the collaboration of teachers of the various degree courses. Printed questionnaires were administrated by trained dietician students and teachers of the Degree Course in Dietetics of the University of Brescia. After a quick presentation of the research purpose and questionnaire's characteristics, students were allowed to compile it on their own. Completion of the questionnaire took approximately 10–12 min.

2.2. Survey instrument

To conduct this study, while respecting the anonymity and privacy of the participants, a paper questionnaire, the "Good APPetite Survey", was drawn up consisting of 14 questions divided into 5 sections:

Section 1, Project description and informed consent: a brief description introduced the aim of the project, the anonymous nature of the questionnaire and the request for written consent to participate in the study, without signature.

Section 2, Demographic information: participants self-reported age, gender and attended degree course.

Section 3, Adherence to Med Diet: participants recorded the daily and weekly frequencies of consumption of fruit, vegetables, legumes, cereals, fish, meat and cured meats, milk and dairy products, alcohol, and olive oil, according to validated Medi-Lite questionnaire (Sofi et al., 2017). A score ranging from 0 to 2 points is awarded for each category and the final score ranges from

0 to 18, indicating low to high adherence to the Med Diet, respectively.

Section 4. Food label and nutrition information readings: students completed 4 items, adapted from previous articles (Ferrara et al., 2019; Graham & Laska, 2012; Nayga et al., 1998; Vasiloglou et al., 2021).

(i) A question in which they self-reported how often they read labels on food and beverages packaging ("Yes, always"; "Yes, often"; "Sometimes"; "No, never"; "I am not in charge of food purchasing").
(ii) If they answered to the previous question "Yes, always" or "Yes, often" or "Sometimes", which of the listed components they pay attention to among: brand, ingredients, allergens, expiration date, net weight, storage and use, place of origin, nutritional information, logo for organic, vegan or gluten-free, all of the above, or other to specify (up to 3 answers were selectable).
(iii) How often they read nutritional information ("Yes, always"; "Yes, often"; "Sometimes"; "No, never"; "I am not in charge of food purchasing")
(iv) If they answered to the previous question "Yes, always" or "Yes, often" or "Sometimes", which component of the nutrition label they usually read among all, caloric intake, content and types of fat and carbohydrates, protein, fibres and salt content, or other to specify (up to 3 answers were selectable).

Students who selected "Yes, always" and "Yes, often" for question (ii) were categorized as food label readers.

Before entering in the fifth section, we introduced a sort of "demarcation question" about the use of n-apps, in the present or in the past, to read nutrition labels and learn about the composition of food ("Yes, always"; "Yes, often"; "Sometimes"; "No, never"; "Used in the past but no longer"). For participants selecting "No, never" the questionnaire ended, while the others were asked to answer the remaining seven questions in the following section.

Section 5, n-app use: participants were asked to list the name of apps currently in use or used in the past (up to3 n-apps) and how they learned about them (friends or family, autonomous search in Google Play or Apple-Store, social network, gym, medical doctor, dietitian or nutritionist, pharmacist, other). A following question was about the reason for using these n-apps (to be informed about the nutritional characteristics of the product, to control body weight, to adopt healthier eating habits, to identify foods rich in protein or more sustainable, to follow a specific diet regimen, to identify allergens, other to specify; up to 3 selectable answers). A 5-point Likert Scale were provided about several aspects that may have influenced the choice of n-apps ($n = 1$ "Not at all influential"; $n = 5$ "Very influential") and the level of satisfaction with defined functionality of the application currently in use ($n = 1$ "Not at all satisfactory"; $n = 5$ "Very satisfactory). The participants were finally asked if they would be willing to pay to upgrade to the premium version of the n-app, and what motivations, if any, prompted them to uninstall the app (time consuming, manual input of products, complexity, costs, failed to meet expectations, inability to monitor and share data, achievement of all targets, other to specify; up to 3 selectable answers).

2.3. Data analysis

The analyses included descriptive statistics (i.e., frequencies and percentages for categorical variables and mean values with standard deviations for continuous variables). Comparisons between groups were made using the X^2 test or Fisher's exact probability test for categorical variables and a p-value less than 0.05 was considered statistically significant for all analyses. Statistical analyses were performed using STATA (Stata Statistical Software: Release 16.0 College Station, TX, USA: Stata Corporation) and graphs processing was performed with Microsoft Excel programme (2016).

2.4. Ethical considerations

The questionnaires were voluntary completed and students were able to withdraw their participation in the survey at any stage and before returning it to the investigators. To guarantee students' confidentiality, an anonymous questionnaire in paper format was used, and all study procedures were in accordance with the provisions of the General Data Protection Regulation (GDPR 679/2016). Due to the anonymous nature of this survey, personal data could not be traced and, consequently, the protocol study did not require the

Table 1
Sample description and n-app use.

	Degree Course				
	MS	Pharm	Diet	MG	Total
Number of Students	135	109	33	39	316
(%)	(42.7)	(34.5)	(10.4)	(12.3)	(100.0)
Percentage of enrollment	8.6	43.9	80.5		
Gender - females number	74	83	25	20	202
(%)	(54.8)	(76.1)	(75.8)	(51.3)	(63.9)
Age (mean ± stand. dev.)	23.5 ± 3.1	20.5 ± 1.3	22.7 ± 5.9	23.3 ± 4.7	22.8 ± 2.7
n-app users number	40	29	26	12	107
(%)	(29.6)	(26.6)	(78.8)	(30.7)	(33.9)
n-app not-users number	95	80	7	27	209
(%)	(70.4)	(73.4)	(21.2)	(69.3)	(66.1)

approval of the local ethics committee.

3. Results

3.1. Sample description

The questionnaire was completed by 316 students attending the course of studies in MS (n = 135; 42.7%), Pharm (n = 109; 34.5%), Diet (n = 33; 10.4%), EWPT (n = 18; 5.7%), ESS (n = 12; 3.8%) and SAS (n = 9; 2.8%). Due to the small number of students, EWPT, ESS and SAS were analysed as "Mixed Group" (MG). Considering the whole number of students enrolled in the three main degree courses for the academic year 2022-23, the following subjects participated in the study: 80.5% of the students enrolled in Diet, 43.9% of those enrolled in Pharm and 8.6% of those enrolled in MS (University of Brescia, 2023). The study population comprised students aged 18–50 years old (mean age 22.8 ± 2.7 years) and the questionnaire was administered between March and April 2023. All the students but two were digital native people, according to the definition by Marc Prensky. Among respondents, 63.9% were females, and 35.1% were males; 1% of the sample preferred not to declare gender (Table 1).

3.2. N-app use

In our sample, 33.9% (n = 107) of the students stated that they use or have used n-apps. According to the degree course attended, Diet was the degree course with the highest, current or past, use of n-apps (78.8% of the students), in comparison with 29.6% of MS and 26.6% of Pharm students (Table 1).

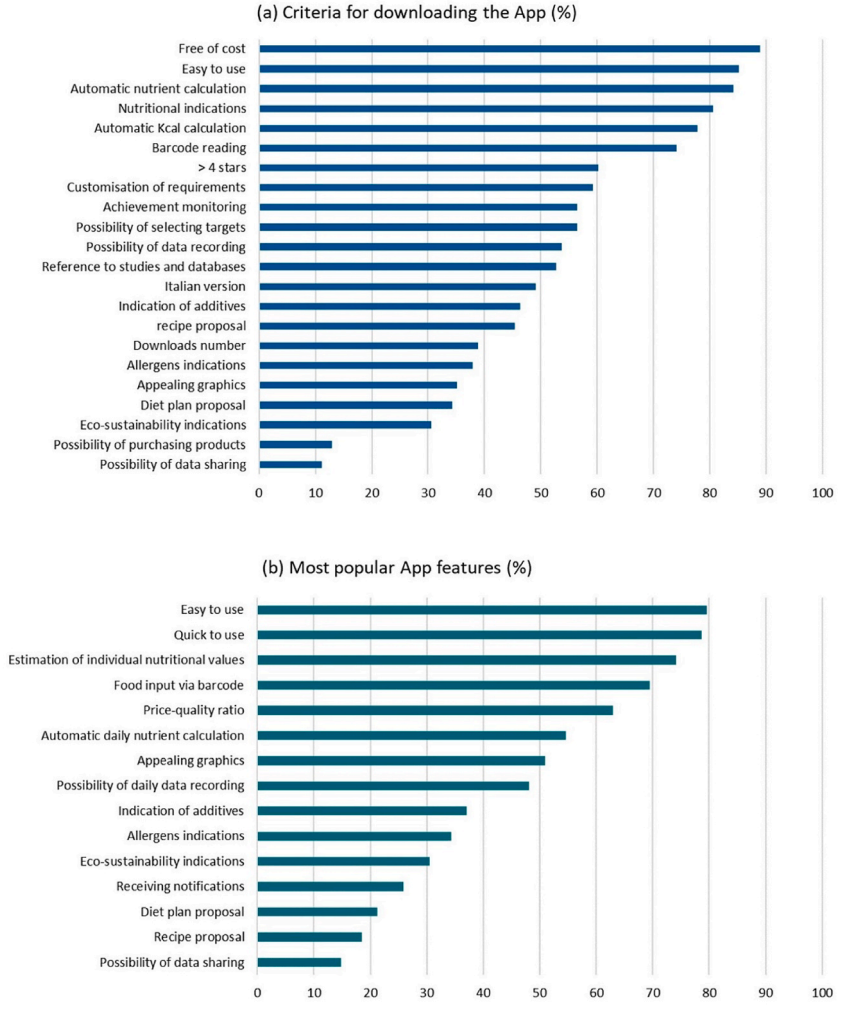

Fig. 1. (a) Criteria for selecting n-apps, expressed as % of positive answers (points 4 and 5 of the Likert Scale). (b) Most popular features of the downloaded n-app expressed as % of positive answers (points 4 and 5 of the Likert Scale).

Among the n-app-users, the "Yuka" app was the most used (40.5% of students), followed by "My Fitness Pal" (14.1%), "Fat Secret" (13.2%) and "Yazio" (10.7%). In 34% of the cases, students learned about the used n-app through relatives and friends, in 26.7% through independent research and in 24% through social media. Only 8.3% of the students were advised by their dietitian or nutritionist and 0.8% by a medical doctor.

The motivations that led the students to download the n-app were to know and evaluate the nutritional characteristics of a certain food (28.6%), to improve their eating habits (27.2%) and to control their body weight (20.1%). Those who selected the answer 'Other' (3.6%) gave the following reasons: controlling the sugar content of food, eating disorders, curiosity, school purposes. To assess the students' motivations to download the n-app, Likert Scale score 4 and 5 were selected as positive scores, and in our population, it emerged that "free version of the app", "simplicity of use" and "automatic calculation of nutrients" were the main reasons, given respectively by 88.9, 85.2 and 84.3% of the population (Fig. 1a). The free version of the apps was chosen by 95.3% of users, only 3.7% (n = 4) chose the paid apps. The features of the apps most appreciated by users are listed in Fig. 1b: "ease of use", "speed", "estimation of individual nutritional values" and the "possibility of reading by barcode" were the most appreciated aspects.

Finally, when asked if they had ever uninstalled an n-app, 75% of respondents answered positively. The main reasons for uninstallation were the following: "too much time-consuming "(28.4% of answers), "unfulfilled expectations" (19.7%) and "manual product placement" (16.2%) (Fig. 2). We noted that in the option "other", 7 subjects (8.6% of respondents) specified "excessive fixation" and "obsession with control".

3.3. Food labels and nutrition information readers

In the present population, 53.2% declared to be food labels readers and females were statistically more represented than males ($p = 0.043$; X^2test). Diet students were the most careful about food information (87.9% were food labels readers), while 45.9% of MS students and 47.7% of Pharm students usually read food labels. Among food label information, the students involved in the study mainly read the expiration date (26.8% of students), the list of ingredients (22.2%), nutrition tables (13.7%), brand name (12.1%) and the country of origin (6.2%). Focusing the attention on nutrition information, 53.5% of the sample usually read them routinely, with Diet students with the highest rate (90.9%) compared to MS (46.7%) and Pharm (46.8%) students (Table 2).

3.4. Adherence to Med Diet

The evaluation of the adherence to Med Diet through the Medi-Lite questionnaire (Dinu, Pagliai, et al., 2021; Sofi et al., 2017) sh owed that scores registered by the sample ranged from 4 to 17, with a mean value of 10.0 ± 2.5. Table 2 shows the values recorded by individual degree courses: Diet students recorded the highest average score (12.2 ± 2.2), followed by the degree course in MS (10.3 ± 2.5) and the course of Pharm (9.1 ± 2.6). When comparing the Medi-Lite values recorded by the different degree courses, the Diet students' scores were significantly higher than all other degree courses ($p < 0.0001$) and the students of MS recorded a significantly higher Medi-Lite score than both students of Pharm and MG ($p = 0.0001$ and $p = 0.0035$ respectively). Dividing the whole sample according to low, medium and high adherence to Med Diet (Medi-Lite score$\leq$7, between 8 and 10 and $\geq$ 11, respectively), we observed that 14.3% (n = 45) had low adherence, 48.1% (n = 152) had medium adherence and 37.7% (n = 119) had high adherence to Med Diet. The prevalence of low, medium and high adherence in the different degree courses are reported in Table 2.

The assessment of adherence to Med Diet according to gender, indicated no significant differences (10.11 ± 2.57 for female and 9.77 ± 2.19 for males; $p = 0.236$), although the percentage of females with high adherence is higher than that of males (39.9% vs 33.3%).

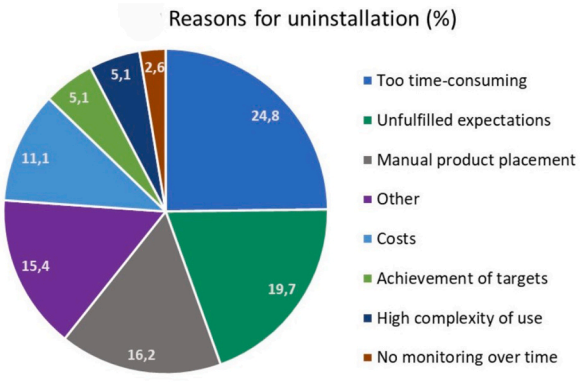

Fig. 2. Reasons that led to uninstallation, expressed as % of total answers collected. Too time-consuming, unfulfilled expectations and the need for manual placement of products are the main reasons for app-uninstallation.

Table 2
Food information and food nutrition labels reading and adherence to Med Diet.

	Degree Course				
	MS (n = 135)	Pharm (n = 109)	Diet (n = 33)	MG (n = 39)	Total (n = 316)
Food information readers number	62	52	29	25	168
(%)	(45.9)	(47.7)	(87.9)	(64.1)	(53.2)
Food nutrition label Readers	63	51	30	25	169
(%)	(46.7)	(46.8)	(90.9)	(64.1)	(53.5)
Medi-Lite score mean ± stand. Dev.	10.29 ± 2.47#	9.11 ± 2.58	12.15 ± 2.18*	9.51 ± 1.88	9.98 ± 2.46
Medi-Lite score ≥11 number	58	27	24	10	119
(%)	(43.0)	(24.8)	(72.7)	(25.6)	(37.7)
Medi-Lite score 8–10 number	61	59	8	24	152
(%)	(45.2)	(54.1)	(24.2)	(61.5)	(48.1)
Medi-Lite score ≤7 number	16	23	1	5	45
(%)	(11.8)	(21.1)	(3.0)	(12.8)	(14.2)

Note: # = significantly higher vs Pharm ($p = 0.0001$) and vs MG ($p = 0.0035$); * = significantly higher vs MS ($p < 0.0001$), vs Pharm ($p < 0.0001$) and vs MG ($p < 0.00001$).

3.5. Correlations between the use of n-apps, the reading of food labels and the adherence to Med Diet

Overall, students using n-apps were significantly more frequently food labels and nutrition information readers than n-app Not-Users (both $p < 0.0001$; X^2 test). Moreover, students using n-apps recorded a Medi-Lite score significantly higher than those who did not use apps (10.4 ± 2.62vs 9.8 ± 2.4; $p = 0.0131$), and Medi-Lite score ≥11 (Med Diet high adherence) significantly correlated with n-apps use ($p = 0.014$; X^2-test).

In addition, frequent food labels readers obtained a Medi-Lite score significantly higher than those who usually do not read food labels ($p = 0.0016$; mean Medi-Lite score among "frequent readers" 10.4 ± 2.6 vs. 9.5 ± 2.1 among "infrequent readers"). Finally, focusing the attention on nutrition information, 53.5% of the population usually read them, and registered a Medi-Lite score significantly higher than to those who do not read this information ($p = 0.0122$; mean Medi-Lite score among "frequent readers" 10.3 ± 2.7 vs. 9.7 ± 2.5 among "infrequent readers").

4. Discussion

At our knowledge, this is the first study investigating n-app use, and its correlation with dietary habits, among a population of university students, mostly digital native. Approximately one third of the sample used n-apps and was significantly more attentive to the information on food packages than the rest of the study population. Furthermore, students using n-apps have a significantly higher adherence to Mediterranean diet than the rest of the sample. The positive correlation of the use of a n-app with better eating habits is consistent with previous research (Samoggia et al., 2020; Scarry et al., 2022), but the extension of the survey to the topic of food labels reading is particularly relevant, especially in this historical period in which the implementation of a FOPL is a matter of debate in the European "Farm to Fork Strategy" (European Commission).

With the increasing consumption of pre-packaged foods and beverages, front-of-pack and nutrition labels are useful for the consumers, who learns about ingredients, nutrients and eventually additives or allergens contained, but at the same time are crucial for the producers as a marketing tool (Martini & Menozzi, 2021). With the present survey we assessed the awareness of students when purchasing food: approximately half of the sample paid attention to both packaging information (general food labelling) and nutrition information, with better results among Diet students (as expected, giving the particular engagement of these students in dietetics themes and their nutritional knowledge background) (Soederberg Miller et al., 2019). In our population, food label awareness was significantly correlated with better eating habits, expressed by a higher adherence to Mediterranean diet, and this result confirmed the bidirectional crosstalk between food label reading and diet quality (Jacob et al., 2020). According to these findings and to the European Green Deal, the design of nutrition education interventions, aimed at helping consumers to read and interpret food labels also through the identification of a comprehensive and effective food labelling model, is of primary importance for the promotion of healthier lifestyle and diet (Todd et al., 2022; Farm to Fork Strategy, 2024).

The evaluation of the adherence to Med diet in the present population showed an average value, with not statistically difference between male and female students, contrary to previous observations, in which the female population was more adherent (Dinu, Pagliai, et al., 2021). We found that students in Dietetics showed a high adherence to Med diet, significantly superior to the other degree courses: Dietetics students seemed to be more sensitive and attentive to the composition of their diet, hypothetically due to the knowledge and skills acquired during their studies, in line with what has already been observed in previous studies (Theodoridis et al., 2018). Lower scores obtained by the students of MS and Pharm, both considered in Italy as healthcare workers, could represent a starting point for projects aimed at improving their own eating habits, as a first step in increasing their confidence even in suggesting healthier diet choices. It is important to emphasise that the MS degree course does not include any teaching dedicated to nutrition and that the Pharm and ESS students followed the teaching dedicated to healthy nutrition at the end of the present project. Comparing our Medi-Lite results with those observed by Dinu and colleagues (Dinu, Pagliai, et al., 2021), the adherence to Med diet was lower. A

possible reason of this result could be that college-aged people, having only recently left the family home, are beginning to make more independent choices about eating and they could adopt unhealthy behaviours, for the lack of cooking skills, of time or money (Graham & Laska, 2012; Romano et al., 2017).

Digital technologies are becoming a crucial resource for public health promotion (mHealth), and mobile technologies are particularly relevant due to their broad reach, wide acceptance and ease of use (WHO; mHealth Use of appropriate digital technologies for public health). Among mHealth apps, the number of the apps for improving nutrition continues to grow, and thousands of nutrition-related mobile apps have been downloaded by millions of users over the past few years, indicating that people are becoming more health-conscious and want to track and manage their nutrition by themselves (Choi et al., 2021; Franco et al., 2016; Martinon et al., 2022). In 2020 in Italy health and fitness apps generated 656 million of downloads and diet-related apps occupied the second position in the google play store's ranking (Statista; health-fitness-apps-downloads-worldwide-2020; Mistura et al., 2021). In the present study, one third (33.9%) of the students were current or previous n-app users. While the data on the use of diet and nutrition-related apps in Italian population are scarce, in US in 2017, 14 percent of survey respondents stated that they regularly use an n-app (Statista; us-adults-that-would-use-an-app-to-track-their-diet 2017). Findings from the present study showed that university students used the n-apps mainly to learn about nutritional characteristics of the purchased food, to acquire or improve their eating habits and to monitor body weight. Concerns about general diet and weight control are the main drivers for n-apps download, as has been previously observed (Fewings et al., 2022). The more appreciated aspects of the n-apps were the freedom from charge, the ease of use, the possibility to count macronutrients and energy and the possibility to scan the barcode of food, and even these results reflect those of previous studies (Chan et al., 2017; Vasiloglou et al., 2020). Although concerns about health and diet may motivate n-apps download, some barriers led to its uninstallation: too time-consuming, unfulfilled expectations and manual product placement account for 60% of the reasons presented. Among reasons that led users to uninstall the app, particular attention should be paid to the risk of excessive and obsessive diet control. Since these apps allow the user to scrupulously assess daily food consumption and exactly calorie counting, they could cause health problems and trigger or maintain eating disorders, especially among adolescents or fragile young subjects (Plateau et al., 2018; Simpson & Mazzeo, 2017; Tosi et al., 2021).

The analysis among n-apps users showed a significantly higher adherence to the Med diet than those who did not use n-apps and, moreover, a significantly higher attitude in reading food labels and nutrition information. These results are consistent with previous findings, where concerns about healthy eating, diet and weight control led to higher likelihood of actively seeking health information on food and using health-related apps (Fewings et at., 2022). Consumers with inclination to make healthy dietary choices were related to higher levels of food labels reading as well (Graham & Laska, 2012; Ni Mhurchu et al., 2018). These healthy attitudes are closely intertwined and, as technology has evolved, the link between reading the information physically on the food packages has extended to the use of n-apps. The positive impact of nutrition-related apps on diet quality has also been highlighted by several intervention studies, in which the use of these digital tools significantly improved weight and metabolic parameters (Villinger et al., 2019).

N-apps mainly used in the present sample were Yuka, MyFitnessPal, FatSecret and Yazio, all listed in the most popular US and European rankings (U.S. News & world report; 2024). Yuka application deciphers products labels and analyses the health impact of both food and cosmetics (https://yuka.io/en/); developed in France in 2017, it is now available in 5 languages, 12 countries and has over 40 million users. The application has a database with more than 2.5 million food products, which is constantly being expanded and declares non manufacturer influence, brands advertise and conflict of interest. By framing the product barcode, it is possible to receive an immediate general product evaluation expressed as a number (range 0–100) and as a traffic light indication, according to the Nutri-Score system, the list of additives and recognised organic label (https://yuka.io/it/stampa/). MyFitnessPal is an application which uses gamification elements for diet and exercise management: based on the personal profile, it recommends caloric and fitness daily targets, proposes a food diary, allows food tracking with barcode scanner and provide daily tips to boost motivation (https://www.myfitnesspal.com/it). This app, in contrast to Yuka, does not provide a qualitative food assessment (traffic light), but a quantitative evaluation through a caloric counting system. FatSecret is a mHealth app for self-monitoring food intake, physical activity and weight loss; a barcode scanner helps to track packaged foods. This app accounts several tools as food and exercise diary, healthy recipes and nutritional information (https://www.fatsecret.com/). Finally, the app Yazio functions as a calorie counter, helps users to manage an intermittent fasting programme, automatically keeps track of fitness activity and steps, and offers several recipes tailored to users' preferences (https://www.yazio.com/en). All these apps also allow to join a web-community to share and receive information.

In recent years, several research groups have evaluated the accuracy of leading nutrition-related apps in terms of calories and macronutrients and found heterogeneous results: Tosi and colleagues observed an overall underestimation of energy and lipids and, in some apps, an overcounting of protein content in comparison to the reference method (Tosi et al., 2021). In the study of Mistura and colleagues, a good agreement between the selected app, two of which were the same ones examined in Tosi's work, and the reference method was found, both in term of energy and macronutrient intake (Mistura et al., 2021). In both cases, however, the authors recognised the usefulness of these tools for monitoring calories and meal composition and emphasised the importance of using accurate databases to calculate food composition. Moreover, they emphasised the importance of promoting collaboration between app developers and experts in nutrition, as Dietitians or Nutritionists to overcome these limitations and to increase the effectiveness and accuracy of these instruments, even in different pathological contexts (Covolo et al., 2017; Mistura et al., 2021; Tosi et al., 2021).

A neglected aspect of currently available n-apps is the evaluation of the consumption of ultra-processed foods (UPF). Nutrition experts, aware of the deleterious effects of overconsumption of these foods, could contribute to the development of n-apps that raise awareness of this food category and provide equivalent alternatives of non-UPF foods (Wang et al., 2024). The development of n-apps that track the percentage of UPF consumed in relation to total calories, with alerts in case of excess, could be an interesting development in this area of m-Health.

In the present study, it was found that health professionals only minimally suggested the use of these apps, and that the majority of

students became aware of the apps through friends, family or social media. It is therefore important for dieticians, pharmacists and physicians to be familiar with these instruments and, especially in the case of dieticians, who are responsible for assessing people's nutrition status, to be able to recommend the most reliable instrument, explaining its use and possible limitations. Worldwide, it has been observed that an increasing percentage of healthcare professionals, who worked with nutrition-related diseases, recommended to their patients/clients to use specific apps, and our data shows how important it is to strengthen the confidence of our specialists in this field (Vasiloglu et al., 2021). Moreover, it has been shown that web and mobile technologies related to nutrition have a greater impact if combined with personalized advice from a dietitian (Rollo et al., 2020).

The major novelty of the present study was the extensive correlation between the use of n-diet and nutrition-related apps, with the food labels consciousness and eating habits expressed as adherence to Mediterranean Diet in a digitally native population. Results showed that attention to food purchasing, through careful reading of labels, also supported using digital tools, is significantly higher in those who have a healthier diet. Similarly, it could be emphasised that a healthier diet is the result of increased knowledge, also obtained through the use of nutritional apps and the reading of food labels. Moreover, this survey allowed us to truck the students' motivations, preferences and limitation of the most used apps, representing a starting point for future projects aimed at more heterogeneous groups of the population, both healthy and with disease.

The present work accounts some limitations: the first concerns the collection of data limited to the University of Brescia, whereas it could be very interesting to assess app usage, label reading and diet adherence in other universities, both in Italy and abroad. Moreover, the cross-sectional nature of the study represents another weakness: we can only describe prevalences and distributions without distinguishing causes and effects. Planning subsequent surveys would also make it possible to assess these habits over time. In addition, the small number of surveys from the degree courses of Prevention Techniques in the Environment and Workplace, Sport Sciences and Agricultural and Sustainable Systems, reason why they have been grouped together, limited opportunities for comparison between different groups of students. Probably, the administration of the survey in a very narrow time window, to also avoid interferences between students, affected the number of participants. Furthermore, in the survey we did not ask about ethnicity, weight, height or any weight changes to reduce the collection of sensitive data.

5. Conclusion

Purchasing healthy food is a key step in building healthier eating habits and young adulthood is a time when individuals begin to make more independent choices (Graham & Laska, 2012), including meal planning. Food label use is significantly and positively associated with healthier eating habits (Ni Mhurchu et al., 2018) and, considering the widespread use of smartphones and the increasing number of diet and nutrition-related apps, healthy dietary decisions can also be facilitated by digital technology. In this study, the link between the use of nutrition apps, attention to food labels and better eating behaviour was demonstrated in a population of university students at the University of Brescia, Italy. Understanding user needs would help researchers and health professional to be much more involved in this field.

CRediT authorship contribution statement

Silvia Marconi: Writing – original draft, Validation, Software, Project administration, Investigation, Formal analysis, Data curation, Conceptualization. **Elisa Carrara:** Writing – review & editing, Investigation, Data curation. **Giulia Gilberti:** Writing – review & editing, Validation, Formal analysis. **Maurizio Castellano:** Writing – review & editing, Visualization, Supervision, Resources, Project administration. **Barbara Zanini:** Writing – review & editing, Visualization, Validation, Supervision, Software, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.smhl.2024.100497.

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