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Nutrition knowledge, attitude, and practice of sustainable healthy diets: a survey of Italian college students (the KAPSULE study)

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ORIGINAL PAPER

Abstract

A key challenge in the nutrition field is identifying strategies to encourage the adoption of sustainable healthy diets (SHD). Current evidence suggests that greater nutritional knowledge is associated with a higher likelihood of choosing a healthy diet. However, the level of knowledge, attitudes, and practices related to SHD within the Italian population has been scarcely investigated so far. The aim of the present work is to validate a questionnaire assessing knowledge, attitudes, and practices regarding SHD among college students attending the University of Milan. A total of 1,491 students completed the questionnaire, which included 26 items and was divided into 3 sections related to knowledge, attitudes, and practices of SHD. Results from the present study show that cultural and social contexts influence both the nutritional and environmental attitudes of the consumers involved. Consequently, nutritional and environmental attitudes affect nutritional and environmental practices. The results also demonstrate that attitude indirectly affects practice through knowledge, which may play a pivotal role in fostering the transition towards SHD in the Italian population. Administering this questionnaire to a larger sample of the Italian population will help clarify which gaps prevent greater adherence to SHD and support the design of interventions to address these gaps.

Keywords: attitudes, nutrition knowledge, sustainable healthy diets, validation

Introduction

It is well recognized that adequate food habits are essential for maintaining human health, while poor dietary habits (e.g., low intake of fruit and vegetables, legumes, and high sodium intake) are associated with many disabilities and deaths (Afshin *et al.*, 2019). Awareness regarding the effect of food systems on planet's health is also increasing, as food production and consumption are responsible for high greenhouse gas "emissions" and (GHGs), land use, and water use (Crippa *et al.*, 2021; Food and Agriculture Organization of the United Nation, 2021; Mrówczyńska-Kamińska *et al.*, 2021; Whitmee *et al.*, 2015). For this reason, it is urgent to identify strategies that encourage the transition toward sustainable healthy diets (SHD) and help to provide sufficient food to the growing world population while limiting the impact on planet's health. The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) defined SHD as *"... dietary patterns*

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that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable. The aims of Sustainable Healthy Diets are to achieve optimal growth and development of all individuals and support functioning and physical, mental, and social wellbeing at all life stages for present and future generations; contribute to preventing all forms of malnutrition (i.e., undernutrition, micronutrient deficiency, overweight and obesity); reduce the risk of diet-related NCDs; and support the preservation of biodiversity and planetary health. Sustainable healthy diets must combine all the dimensions of sustainability to avoid unintended consequences" (World Health Organization & Food and Agriculture Organization of the United Nations, 2019). This definition clearly highlights that the guiding principles of SHD, including human health, environmental impact, and socio-cultural aspects, must be considered to achieve goals related to the overall sustainability of the food system.

To promote people's adoption of SHD, several actions can be undertaken. Among these, the development of national-based nutritional guidelines that account for the main principles of SHD, as well as measures aimed at enabling behavioral change, may play a key role. Increasing nutrition education is also crucial. It should aim to improve nutrition knowledge and attitude on SHD, which in turn may provide the basis for increasing the practice of these sustainable dietary models. This is important considering that people often focus on only a few elements, such as low environmental impact, local supply chains, or animal welfare standards, as key aspects of food sustainability while overlooking many other crucial elements of sustainable diets (van Bussel *et al*., 2022).

Indeed, recent evidence shows that people who know more about nutrition are more likely to switch to healthier and more sustainable diets. This highlights the importance of making nutrition knowledge a primary goal of education campaigns aimed at encouraging long-lasting healthy eating behaviors (Vallée *et al*., 2022; Sahin & Sanlier, 2025; Arslan & Alataş, 2023; Lawrence, 2024).

Although many studies have investigated the complex interaction between knowledge, attitude, and practice (KAP), to the best of our knowledge, no studies have focused on the different guiding principles of SHD as defined by FAO/WHO.

Based on these considerations, the aim of the present study - KAPSULE (Knowledge, Attitude and Practice toward SUstainabLe dietary modEls) - was to validate a KAP questionnaire on SHD among college students attending the University of Milan.

Hypotheses Development and Conceptual Framework

Food is an essential part of people's lives and is not just a means of survival. Indeed, there are considerable social forces at work behind how and what we eat (Pachucki & Breiger, 2018).

Thus, eating behavior, like any complex human behavior, is influenced by many interrelated factors and cannot be entirely explained by physiological or nutritional needs (Shepherd, 1999). The identification of these factors is crucial to better understand eating behaviors in a society where food demand is constantly increasing. While the growing food demand drives the food industry to investigate the main factors responsible for food choice, it also results in higher production, which has significant effects on our planet. The depletion of natural resources, climate change, air pollution, and waste generation caused by the increased food demand require research to identify factors that may promote sustainable consumption and behavior (Hessam Zand & Parisa, 2013).

Determinants of food choices and the adoption of environmental behaviors have been widely investigated in the literature (Monteleone *et al*., 2017; Baraldi *et al*., 2018). However, in the area of healthy and sustainable choices, several aspects still need to be clarified.

Therefore, in accordance with the KAP definitions, this study investigates the role of individual socio-cultural contexts, attitudes, and knowledge on diet-related practices, considering both the nutritional and environmental aspects.

Cultural and social contexts

Cultural factors play an important role in the choices we make. When it comes to food, each culture has a set of complex values that govern what we choose to eat, how we prepare food, and with whom and how the food is served (Hyldelund *et al*., 2022).

Ares *et al*. (2016) demonstrated that diverse cultures are likely to give importance to different aspects when assessing their own subjective food preferences, beliefs, and choices. The cultural context can affect how various tastes are perceived depending on exposure to different foods (Ares *et al*., 2016). Many studies also report that geographical and cultural differences primarily affect attitude and the actual choice of certain foods. People often connect to their cultural or ethnic group through specific food patterns. Indeed, food is frequently used as a means of retaining cultural identity, which explains why people

from different cultural backgrounds eat different foods. The areas where families live and where their ancestors originated influence food likes and dislikes. These food preferences result in patterns of food choices within a cultural or regional group (Sibal, 2018). Similarly, since food is predominantly consumed in the presence of other people, making it an important promoter of social relations (Cruwys *et al*., 2015; Rozin, 2005), it is expected that food behavior is also deeply affected by social factors. For example, Wthitelock & Ensaff (2018) showed that the presence or absence of a partner in old age significantly changes eating habits, both in terms of quantity and in the attention given to meal preparation.

Furthermore, Frawley highlighted that the adoption of a vegan lifestyle may result from a social context that encourages reducing animal product consumption with the aim of lowering the environmental impact of our diets.

The same study shows that social and cultural contexts are also able to influence the adoption of sustainable lifestyles (Frawley, 2017).

Additionally, Soini & Dessein (2016) identified knowledge of the environment as a key cultural aspect in nature conservation and local livelihoods.

Thus, literature confirms that cultural differences drive awareness and concern regarding environmental problems. This correlation is not new, as Van Liere and Dunlap coined the term "the social bases of environmental concern" in 1980 to describe the ideologies linked to social and cultural aspects that affect how individuals perceive the reality and urgency of environmental problems (Liere & Dunlap, 1980).

Thus, to better understand food choices and sustainable behaviors, cultural aspects should be taken into consideration (Ares, 2018; Duerlund *et al*., 2020; Fischler, 1988; Lee & Lopetcharat, 2017).

One of the goals of the current study is to explore how societal and cultural contexts may affect attitudes and behavior. In particular, it focuses on nutritional and environmental outcomes by testing the following hypotheses:

- H1: The cultural and social contexts affect individuals' pro-environmental behaviors.
- H2: The cultural and social contexts affect nutritional practices.

Knowledge, attitudes and practices

The adoption of specific behaviors often depends on individual attitudes. The FAO defines attitudes as "emotional, motivational, perceptive, and cognitive beliefs that positively or negatively influence the behavior or practice of an individual" and highlights that "attitudes influence future behavior no matter the individual's knowledge and help explain why an individual adopts one practice and not another" (Fautsch Macías & Glasauer, 2014).

Both eating and sustainable behaviors are likely to be mediated by the attitudes and beliefs of an individual. According to Rothe (1996), individual beliefs can play a key role in the final choice of food. Economic, social, and demographic factors, along with personal experiences, habits, and personality traits, can mediate behaviors by acting through individual attitudes and values (Rothe, 1996). Kaiser *et al*. (2007) demonstrated that behavior-based attitudes are an effective predictor of green behaviors (Kaiser *et al*., 2007). It was later highlighted that attitudes can increase the purchase of green products (ElHaffar *et al*., 2020).

Other studies showed that attitudes and beliefs are also able to influence consumers' nutritional choices (Mathras *et al*., 2016; Ahmad *et al*., 2015). Therefore, it is hypothesized that:

- H3: Attitudes/beliefs towards environmentally sustainable lifestyle have a positive direct effect on environmental behavior.
- H4: Attitude/beliefs towards nutrition have a positive direct effect on nutritional behavior.

The conceptual framework is reported in Figure 1.

Nevertheless, individual attitudes do not always directly affect eating behavior, as it can be mediated by other factors, especially consumer knowledge. Several studies demonstrated that higher levels of knowledge can override social beliefs – related to social context, religion, etc. – promoting healthy and sustainable choices. For instance, Iaccarino Idelson *et al*. (2020) demonstrated that higher consumer knowledge increases the probability that consumers change their beliefs regarding the effects of excessive salt consumption, thus increasing the likelihood of reducing it (Iaccarino Idelson *et al*., 2020).

The present study focuses on the role of nutritional and environmental knowledge as mediators between attitude and eating behavior. To this end, it is important to consider how beliefs affect knowledge. Lee & Cheon (2018) investigated how beliefs and parental attitudes may affect studies and knowledge in different fields and noted that such beliefs may potentially increase the willingness to study and deeply explore a specific field. In light of this, we can hypothesize

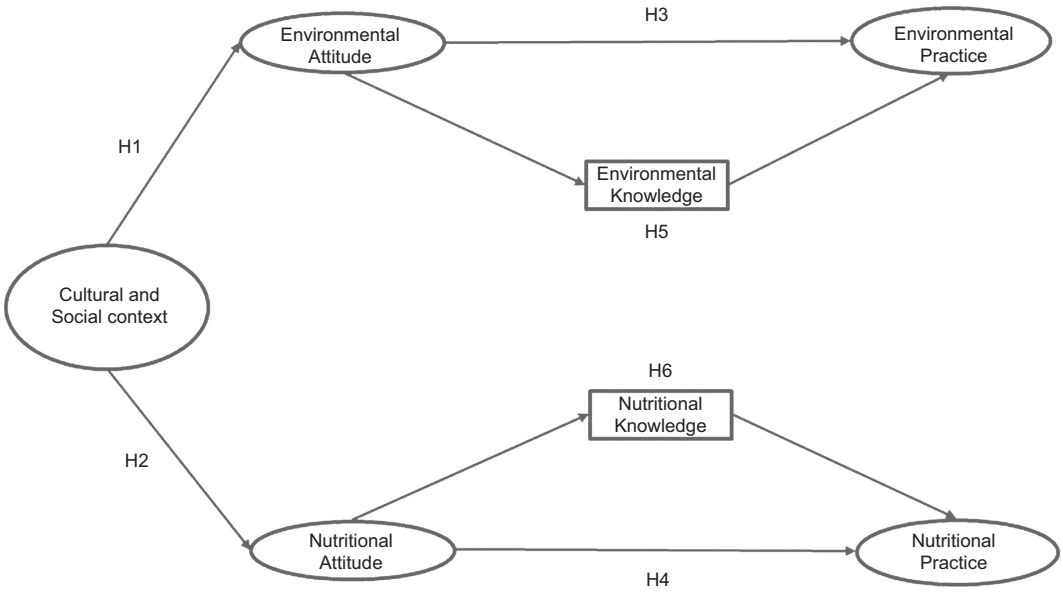

Figure 1. The conceptual framework.

that a similar pattern exists in the nutritional field. Therefore, the stronger the attitudes toward the area of nutrition and environmental issues, the stronger the willingness to become informed and the easier it is to develop knowledge about these issues. The importance of knowledge was also emphasized by Bradette-Laplante *et al*. (2017), who demonstrated that nutrition knowledge can be considered one of the determinants of food choices. This was further supported in the literature by Parmenter and Wardle (2000), who developed and patented the General Nutrition Knowledge Questionnaire (GNKQ). This tool enables researchers to quantify nutritional knowledge in a sample and study its effect on eating behavior. Scalvedi *et al*. (2021) again demonstrated how knowledge of certain aspects of nutrition can influence food behavior, especially when knowledge is related to the effects of food on consumers' health.

Thus, defining knowledge as "an individual's understanding of nutrition, including the intellectual ability to remember and recall food- and nutrition-related terminology, specific pieces of information and facts" (Fautsch Macías & Glasauer, 2014), and considering the aforementioned role of beliefs and knowledge in modifying eating behavior, the current study will also focus on the following hypotheses:

- H5: Nutritional knowledge mediates the effect of attitudes on nutritional behavior.
- H6: Environmental knowledge mediates the effect of attitudes on environmental behavior.

Materials and Methods

Study population and questionnaire

The analysis is based on data collected through an online questionnaire distributed among bachelor's and master's degree students attending the University of Milan. Starting from September 2021, students from the University of Milan were invited to participate via an email sent to all students included in the university's mailing list. The final sample consisted of 1,491 individuals. Students were eligible if they were enrolled in a bachelor's or master's program, and no other restrictions were applied. Informed written consent was obtained from all volunteers to participate in the study, and they were assured of complete anonymity. The study protocol was approved by the Ethics Committee of the Università degli Studi di Milano (protocol number 104/20 - Allegato 7).

The questionnaire is anonymous and includes items with multiple-choice responses or rating scales (dummy and ordinal variables ranging from 1 to 5, or from 1 to 3). The different items of the questionnaire were based on pertinent items from the FAO/WHO document on SHD (World Health Organization & Food and Agriculture Organization of the United Nations, 2019), to cover the different dimensions of the topic. Initially, a pool of 80 items was generated by a group of experts on nutrition and food policy. According to previous studies, each expert on the panel was asked to indicate whether an item was "essential" or "not essential" to the operationalization of a theoretical construct. Then, the content

validity ratio was calculated, yielding values that ranged from +1 to −1, with positive values indicating that the item was considered "essential" by at least half of the experts. This process resulted in 33 items, plus questions related to sociodemographic variables including sex, weight, height (used to calculate body mass index (BMI) as body weight (kg)/height (m)), smoking habits, level of activity, and number of people in the household.

The items were grouped into three sections based on their themes. The first part focused on what people know about SHD (such as the amount of nutrients in foods, how often they should be eaten, the food pyramid, and how foods affect the environment). It included objective knowledge questions that were scored with a 1 for a correct answer and a 0 for an incorrect answer or "don't know." This coding made it possible to calculate a total knowledge score.

The second part, which focused on feelings toward SHD (such as perceived benefits, importance, perceived barriers, self-efficacy, and readiness to transition), included statements that were rated on a 5-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree").

The third part, which examined SHD-related behaviors such as eating habits and food purchasing patterns, used a 5-point frequency scale, with 1 meaning "never" and 5 meaning "always."

In addition to the three main sections, a set of socio-demographic questions was added to describe respondents in terms of gender, age, income, smoking status, and general lifestyle. The questionnaire underwent a pre-test with a small sample of 20 consumers, during which some modifications were made to improve its clarity and comprehension. A number of variables are anticipated to be fundamental in demonstrating the extent to which cultural and social factors shape environmental and nutritional attitudes and practices.

Following the structural equation approach, we used a set of manifest indicators to better explain the unmeasured latent variables. As shown in Table 1, in the econometric model, the latent variables are represented by cultural and social contexts, environmental attitude, environmental practices, nutritional attitude, and nutritional practices. Each latent variable is expressed by specific indicators. The links between the variables were established based on economic literature and later tested in statistical terms.

Environmental knowledge and nutritional knowledge were operationalized as a composite score, obtained by summing correct responses to binary-scored items (0 = incorrect; 1 = correct). This index was treated as an observed variable in the SEM.

Approach to the analysis

The data were analyzed using STATA for the descriptive statistics (e.g., variable mean, standard deviation) and to perform the Structural Equation Modeling (SEM). The SEM is a multivariate statistical method that combines factor analysis and multiple regression analysis and is used in social and behavioral sciences to test theoretically supported structural relationships. This method overcomes the main limitation of classic regression models, as it allows for the simultaneous estimation of multiple and interrelated relationships among dependent and independent variables (Christ *et al*., 2014; Henseler *et al*., 2009).

After elaborating the theoretical framework based on the hypotheses specified in section 2, we followed two main steps.

Firstly, we defined the latent variables, each expressed by multiple measured variables (i.e., indicators), grouped through a Confirmatory Factor Analysis (factor loadings data available upon request). Sampling adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) test. The overall KMO value was 0.860, confirming the suitability of the data for factor analysis.

As with most constructs in the model (e.g., attitudes and practices), knowledge was treated differently. Environmental and nutritional knowledge were each assessed with multiple binary-scored items (1 = correct, 0 = incorrect), and for each knowledge domain these items were summed to form composite observed indices, which were later integrated into the model as observed variables. This decision was made because the items captured specific factual knowledge, and, in this case, aggregation rather than reflective modelling was more suitable. It is permissible within SEM frameworks to incorporate variables with different types of scales because the estimates are based on variance–covariance structures, which are robust to differing measurement formats. Secondly, we applied the structural equation modelling approach based on the estimation of two sub-models. The first is the measurement model (or inner model), which refers to the relationships between the dependent latent variable and the independent latent variables. In our model the dependent latent construct is represented by the cultural and social contexts, while the independent latent constructs are environmental attitude, environmental practices, nutritional attitude, and nutritional practices, with all details on the measured variables used to generate latent constructs provided in the following sections. The second sub-model is the structural model (outer model), which refers to the relationships between latent variables and their indicators. In our study, the relationships between latent variables and indicators were defined through a

Table 1. Summary statistics of all items, with related Acronym, mean and Standard deviation.

Items	Acronym	Mean	Std. deviation
Cultural and Social context (α=0,72)			
The social context can influence food choices.	SOCIAL 1	3.737	0.501
Considering the methods of cultivation. food processing. and food production is healthy for people and sustainable for the environment.	SOCIAL 2	3.716	0.496
Food prices make it hard for people to adhere to healthy and environmentally sustainable diet patterns.	SOCIAL 3	3.265	0.831
My food choices are based on respect of cultural traditions	SOCIAL 4	2.302	0.873
I feel ready to change the methods of preparing food (i.e. cooking methods) to follow a healthy and sustainable diet	SOCIAL 5	3.118	0.767
When you buy a food product or prepare recipes. do you consider the local culture of the environment in which you live?	SOCIAL 6	2.283	0.893
Environmental attitude (α=0.75)			
Food influences the environmental health	ENV_ATT1	2.674	0.838
It is important to follow a healthy and sustainable diet in order to protect the environmental health	ENV_ATT2	2.897	0.703
It is difficult to follow a low environmental impact diet	ENV_ATT3	3.247	0.749
My diet has a low environmental impact	ENV_ATT4	3.116	0.736
I feel ready to follow a low environmental impact diet pattern	ENV_ATT5	2.484	0.942
Natural resources depletion (e.g. water, fishery products) is a current major problem	ENV_ATT6	2.868	0.925
Environmental practices (α=0.81)			
Do you sort waste correctly?	ENV_PRA1	2.530	0.869
Do you pay attention to environmental certifications on labels when you buy food? (e.g. rainforest alliance, fair trade, organic agriculture certification)	ENV_PRA2	3.736	0.503
When you go shopping, do you buy bulk products or products packaged with recyclable materials?	ENV_PRA3	3.843	0.397
When you go shopping. do you prefer food products with low environmental impact?	ENV_PRA4	2.317	0.965
Do you try to buy and consume mostly local food products?	ENV_PRA5	2.814	0.867
Do you read the indication of the type of farming on the labels of the products that you buy (e.g. meat and eggs)?	ENV_PRA6	2.508	0.833
Nutritional practices (α=0.71)			
Do you try to follow a balanced diet that includes all the food groups?	NUT_PRA1	2.728	0.773
Do you consume at least 5 portions a day of fruit and vegetables?	NUT_PRA2	2.892	1.014
Do you consume processed meat (i.e. cured meat and sausages) more than once a week?	NUT_PRA3	3.777	0.456
Do you consume cereals and cereal products (i.e. bread and pasta) mostly in their whole grain version?	NUT_PRA4	3.747	0.507
Do you consume mainly water compared to other drinks?	NUT_PRA5	2.335	0.885
Nutritional attitude (α=0.78)			
Following a healthy diet is hard	NUT_ATT1	2.370	0.765
I follow a healthy diet	NUT_ATT2	3.170	0.772
I feel ready to adopt a healthier diet pattern	NUT_ATT3	3.803	0.465

reflective measure specification, in which the latent construct is assumed to exist independently of the indicators used, and variation in the measured variables does not cause variations in the construct. Each manifest variable is assumed to be a linear function of its latent variable and its residual, and, in reflective models, adding or dropping an item does not change the conceptual domain of the construct (Leone *et al.*, 2017). The outer relationships depend on the predictor specifications, and it is assumed that no correlations exist between outer residuals and the related latent variable.

Before testing the model, we performed all descriptive statistics and checked for internal consistency of the

relevant variables while accounting for missing data. As a final step, we examined the validity of the structural model.

Results and Discussion

Sample size and characteristics

A total of 1,491 subjects attending the University of Milan were included in the final analysis. Characteristics of the subjects are reported in Table 2. Briefly, about 73% were females and about 75% were born after 1997 and thus considered Zoomers, while the remaining 25% were Millennials (i.e., born in the 1981–1996 period). Most of the subjects live in households with children (67%) and are non-smokers (84%). Regarding activity level, approximately 2 out of 3 subjects declared a medium-active lifestyle, while 24% were sedentary and only 12% were active. Regarding BMI, 72.5% had a self-reported BMI within the normal weight range, 12% were overweight or obese, and 15% were underweight.

Model testing and main results

There are several fit indices to consider in structural equation modeling. In this paper, we took into account the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA). The values for CFI (0.90), TLI (0.89), and RMSEA (0.042) indicate an adequate model fit. The results of the SEM are illustrated in Figure 2, with arrows representing the relationships between latent constructs.

As also shown in Table 3, cultural and social contexts directly impacted both the nutritional and environmental attitudes of the consumers involved in the study, thus confirming H1 (i.e., the cultural and social contexts affect individuals' pro-environmental behaviors) and H2 (i.e., the cultural and social contexts affect nutritional practices). This is in line with previous studies suggesting the effect of diverse facets of culture on the perception and practices of sustainability. For instance, Lizcano-Prada and colleagues (2024) found large variability in terms of perception and engagement in food sustainability across

Table 2. Sample characteristics.

Items	Frequency	Percent	Items	Frequency	Percent
Age			**Smoking behavior**		
Born after 1996 (Zoomer)	1125	75.5	Yes	245	16.4
Born before 1996 (Millennial)	366	24.5	No	1246	83.6
Gender			**Lifestyle**		
Female	1088	73.0	Sedentary	359	24.1
Male	378	25.4	Medium	954	64.0
Other	25	1.7	Active	178	11.9
Income			**Specific dietary habits**		
Less than 1500€	210	14.1	No	1211	81.2
1500-2500€	385	25.8	Yes	280	18.8
2500-4000€	379	25.4	Vegan	83	
More than 4000€	138	9.3	Vegetarian	110	
Prefer not to say	379	25.4	Celiac	30	
Body mass index			Other	57	
Underweight	223	15.0			
Normal weight	1081	72.5			
Overweight or obese	186	12.5			
Household size					
Single	34	2.3			
Family without children	452	30.3			
Family with children	1005	67.4			

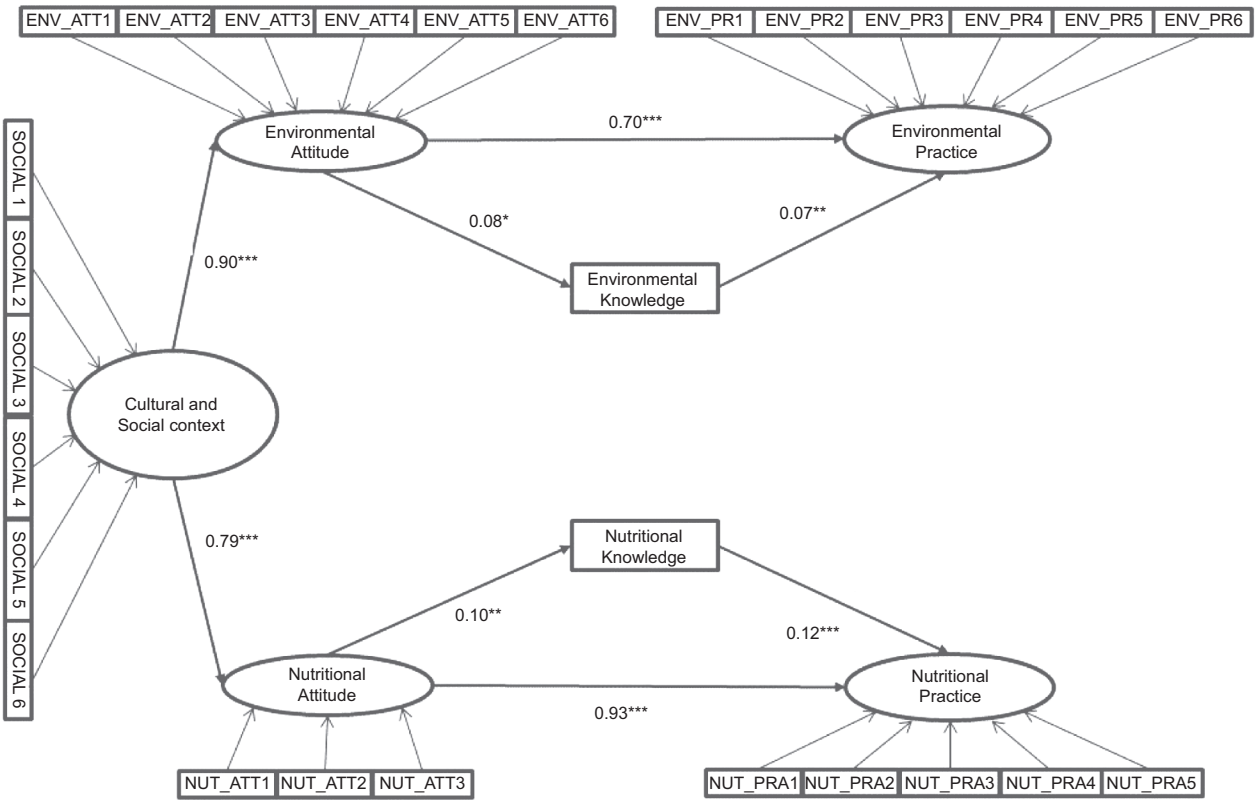

Figure 2. Structural equation model between nutritional and environmental knowledge and attitude and cultural and social contexts. Note: Ovals represent the latent variables, whilst measured variables are indicated in rectangles. The path coefficients of each arrow can be interpreted as common regression weights. ***indicate significance at the 0.001 level.

Table 3. Path Coefficients and Model Fit.

	Coeff	S.E.
Cultural and Social context —> Environmental attitude	0.902***	0.024
Cultural and Social context —> Nutritional attitude	0.788***	0.027
Cultural and Social context —> Environmental practices (total effect)	0.738***	0.028
Cultural and Social context —> Nutritional practices (total effect)	0.667***	0.032
Environmental attitude —> Environmental Knowledge	0.080*	0.034
Environmental attitude —> Environmental practices	0.698***	0.027
Environmental Knowledge —> Environmental practices	0.066**	0.024
Nutritional attitude —> Nutritional Knowledge	0.102**	0.036
Nutritional Knowledge —> Nutritional practices	0.124***	0.028
Nutritional attitude —> Nutritional practices	0.926***	0.045
RMSEA	0.042	
CFI	0.906	
TLI	0.892	
SRMR	0.047	

Notes: CFI, Comparative fit index; RMSEA, Root mean square error of approximation; SRMR, Standardized Root Mean Square Residual; TLI, Tucker–Lewis index; ***p < 0.001, **p < 0.01, *p < 0.05.

three countries (Spain, Turkey, and Colombia) with distinct economic, cultural, and demographic differences (Lizcano-Prada *et al*., 2024). The role of sociocultural influences (e.g., gender, religions, cultural prohibitions) on food choices and sustainable behaviors has also been observed by Monterrosa and coworkers, highlighting the need to consider these influences when making food policy decisions (Monterrosa *et al*., 2020).

In our study, nutritional and environmental attitudes were found to significantly affect nutritional and environmental practices, respectively, thus confirming H3 (i.e., Environmental attitudes have a positive direct effect on environmental behavior) and H4 (i.e., Nutritional attitudes have a positive direct effect on nutritional behavior).

In addition, total effects from the cultural and social context to nutritional practices ($\beta = 0.66$, $p = 0.000$) and to environmental practices ($\beta = 0.73$, $p = 0.000$) were computed and found to be statistically significant. These results confirm the mediating role of attitudes in linking socio-cultural contexts to sustainable dietary behaviors.

Results from the present study demonstrated that, besides the direct relationship between attitude and practice, attitude also indirectly affects practice through the role of knowledge, as shown in Figure 2. This indirect relationship confirms H5 (i.e., Nutritional knowledge mediates the effect of attitudes on nutritional behavior) and H6 (i.e., Environmental knowledge mediates the effect of attitudes on environmental behavior). These findings align with existing literature showing that knowledge may mediate the relationship between attitude and behavior. Indeed, previous studies in Turkish and Swedish populations found that the relationship between food safety knowledge and behavior was mediated by attitudes (Marklinder *et al*., 2022; Sanlier & Baser, 2020). Similarly, the mediating role of attitude between knowledge and practices was noted in a study investigating KAP of healthy eating among Chinese adolescents (Jiang *et al*., 2024).

On the one hand, this result suggests that individuals with a higher knowledge of food sustainability are more likely to follow dietary patterns in line with the principles of SHD. This is consistent with the results of a recent cross-sectional study performed in Italy, which investigated the relationship between sustainability attitudes, knowledge, and eating behavior in 449 subjects. The study found that the overall knowledge score was a strong predictor of both a positive attitude score and the likelihood of eating more sustainably (Gianfredi *et al*., 2024).

On the other hand, findings from the present study suggest that educational interventions aiming to increase sustainable practices should also focus on filling the gaps in knowledge about the different SHD principles.

This study has strengths and limitations to highlight. Among the limitations, we used a self-reported questionnaire, which – despite facilitating administration to many people – can be prone to some biases. Moreover, the study involved a highly educated population, so the results may not be applicable to the general population. Again, while existing research shows that pro-environmental attitudes may affect eating habits, this relationship was not explored in our model. Lastly, the study lacks socio-demographic variables in the structural model because of sample size limits and uneven distribution across some categories. In fact, despite the availability of demographic data, such as age, gender, and income, the imbalanced representation of subgroups made multigroup or moderation analyses less reliable.

Among the strengths, the study included a large number of individuals. Moreover, to the best of our knowledge, this is the first study investigating KAP with a focus on SHD principles as defined by FAO/WHO, covering the different domains of sustainability in the food system.

The main findings of this study confirm the strong relationship between knowledge, attitude, and practices in the context of sustainable healthy diets. The study's results could be considered by stakeholders interested in supporting the shift towards SHD and could serve as a starting point for designing and implementing actions to push this shift forward.

In the meantime, the administration of the KAP questionnaire to a wider population and to specific target groups (e.g., family members in charge of purchases, adolescents) could provide useful insights. These insights could help in developing targeted educational intervention strategies aimed at promoting more sustainable and healthy food choices.

Conclusion

The current research emphasizes the correlation among knowledge, attitude, and practice relating to an SHD. This goes beyond the correlation of knowledge and behavior, as our results showed a significant indirect effect of attitude, thus confirming its mediating influence between knowledge and dietary practices. These results affirm the hypothesis that enhancing attitudes toward sustainable eating is a crucial intervention for motivating actions that promote both human and planetary wellbeing.

From a policy standpoint, the findings provide useful insights for creating nutrition- and sustainability-related programs. These programs should focus on improving adherence to SHD, especially among younger people like college students. However, considering the limitations of the study, future research should investigate the connection between pro-environmental attitude and eating habits by using integrated behavioral frameworks to examine how environmental values influence food choices. Moreover, future research should focus on replicating the findings of the present study in larger and more diverse groups. This will allow for the inclusion of sociodemographic factors and the testing of more detailed models. Doing so could help create food policies that meet the specific needs of different groups and help identify key areas of knowledge or attitude gaps that need attention to encourage a broader shift toward sustainable food practices.

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Ethical Statement

The ethical approval for the involvement of human subjects in this study was granted by the Ethics Committee of the Università degli Studi di Milano, protocol number 104/20 Allegato 7. Participants were informed about the general aim of the study and provided informed consent prior to the start of the survey. They were informed that they would participate in the survey using their personal smartphone or laptop, that all data would be de-identified and only reported in the aggregate, and that they could withdraw from the survey at any time.

Authors Contribution

Elisa De Marchi: Writing – original draft, Methodology, Investigation, Formal analysis. Cristian Del Bo': Conceptualization, Investigation, Writing–review & editing; Daniela Martini: Conceptualization, Writing – original draft, Supervision, Alessia Cavaliere: Conceptualization, Visualization, Data curation, Writing – review & editing,

Conflicts of Interest

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