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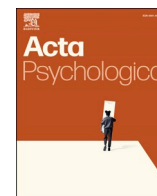
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The use of food barcode scanner app among women: Associations with orthorexia, diet and emotions

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ABSTRACT

This cross-sectional study investigated the relationship between the use of food barcode scanner app (FBSA) and orthorexia, diet and emotions. A total of 1610 women from the general population were included in this study, 388 of whom were FBSA users. Participants completed questionnaires assessing socio-demographic and health characteristics, food barcode scanner use (Food Barcode Scanner App Questionnaire), orthorexia (Teruel Orthorexia Scale), food choice motivations (Food Choice Questionnaire), health anxiety (Health Anxiety Questionnaire), and emotional competence (Profile of Emotional Competence). The results showed no difference in socio-demographic characteristics between FBSA users and FBSA non-users. However, FBSA users scored higher on healthy orthorexia and health anxiety than non-users. FBSA users' food choice motivations were also more focused on natural food content, health, weight control and ethical concerns than non-users. Although no difference was found between FBSA users and non-users for orthorexia nervosa, orthorexia nervosa and pathological FBSA use scores were positively correlated. Moreover, health anxiety scores were positively correlated with FBSAQ "pathological use" subscale. While FBSA use may promote the adoption of a healthy diet, vigilance is required for individuals with orthorexic symptoms and health concerns. These two dimensions could be risk factors for problematic FBSA use.

1. Introduction

In recent years, food barcode scanner apps (FBSA) have been developed to help individuals with their food choices (Soutjis, 2020). By scanning food barcodes, these apps provide nutritional (e.g., Nutri-Score) and environmental (e.g., Eco-Score) properties, as well as information on ingredients (e.g., "healthy", "toxic"). The functionalities of these apps vary considerably. For example, some only decipher ingredient lists on the basis of "scientific evidence" – whose origin and interpretation can sometimes be questionable (Maringer et al., 2019; Soutjis, 2020) – while others offer recommendations for healthier alternatives, assistance from health professionals, food diary and recipes. Two survey institutes have found that between 17 % and 25 % of French adults would use FBSAs (IFOP, 2019; OpinionWay, 2019), but to date, few studies have focused on the users of these FBSAs. Indeed, studies on FBSAs typically focus either on the design of the app (e.g., which of several designs is the best [Ahmed et al., 2020; Ni Mhurchu et al., 2017]) or on the effectiveness of using FBSAs as part of a prevention program (e.g., reducing sugar intake [Bradley et al., 2020; Eyles et al., 2023; Mahdi

et al., 2022]).

To better understand how FBSAs are used and who uses them, Hanras et al. (2024) conducted a study of 1626 French-speaking women. It was found that 25.77 % of the participants reported using at least one FBSA. Users were more likely to visit a healthcare professional than non-users, although they were not more likely to have a chronic disease. The authors suggested that a) the high rate of consultation of healthcare professionals observed among users may reflect a fear of disease (i.e., health anxiety) and b) the use of these apps may allow some users to regulate their anxiety, but may also promote anxiety in some others. However, this study did not investigate whether health anxiety and emotion regulation were related to FBSA use. Therefore, further research is needed to understand the relationship between FBSA use and emotional dimensions, such as healthy anxiety and emotional competences. Indeed, health anxiety, defined as the preoccupation with health in the absence of a diagnosed pathology or an excessive preoccupation comorbid with a disease (Lucock & Morley, 1996), seems particularly relevant to better understand FBSA use. Similarly, intrapersonal emotional competence, which assesses an individual's ability to identify,

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understand, express, regulate and use emotions (Brasseur et al., 2013), is also pertinent considering the large literature regarding eating and emotion.

Several researchers have also suggested that FBSA use may be indicative of orthorexia nervosa (OrNe [Hanras et al., 2023; Lecerf, 2019]). OrNe is defined as a psychopathological preoccupation with the quality of eating, resulting in impaired functioning (Donini et al., 2023), and is associated with health anxiety (Gajdos et al., 2021; Greville-Harris et al., 2022; Kiss-Leizer et al., 2019; Tóth-Király et al., 2021). Based on empirical and clinical evidence, a bidimensional conceptualisation of orthorexia has been proposed to distinguish its healthy form (HeOr: interest in healthy eating without impaired functioning) from its pathological form (OrNe [Barrada & Roncero, 2018; Bratman, 2017]). Individuals with OrNe tend to eat only “pure” foods (Cena et al., 2019). These foods can be selected by checking the food components of products by, for example, reading their labels. Researchers (Hanras et al., 2023; Lecerf, 2019) have hypothesized that individuals with OrNe may also use FBSA to exclude unhealthy foods. However, no study has tested whether FBSA use is associated with OrNe.

The reasons for the food choices associated with orthorexia are currently being questioned. OrNe was originally defined as intending to promote optimal health (Bratman, 1997; Bratman & Knight, 2000; Dunn & Bratman, 2016). Food choices were, therefore, focused on health-related dietary practices (e.g., processed foods, too fatty, too salty/sweet [Dajon et al., 2021; Dunn & Bratman, 2016; Hristova & Marinov, 2020; Lopes et al., 2020]). However, using the bidimensional conceptualisation of orthorexia, Depa et al. (2019) showed that OrNe scores were positively predicted by the food choice motives “weight control” and “mood” and negatively by “sensory appeal”, while HeOr scores were positively associated with “health content” and negatively with “sensory appeal” and “price”. The associations between FBSA use, orthorexia and food choice motives, therefore, need to be clarified.

Furthermore, Hanras et al. (2024) have shown that while FBSA use can promote the adoption of healthy eating, it can also be detrimental for some users, who may become dependent from FBSA use. Indeed, the *Food Barcode Scanner App Questionnaire* (FBSAQ), which they developed, identified three dimensions specific to FBSA use, namely pathological use, food preoccupation, and exclusion of unhealthy components. The “pathological use” FBSAQ subscale was, for example, associated with chronic illness and frequency of use of the app. Other factors associated with problematic use need to be identified for preventive purposes.

Thus, the overall aim of this study is to better understand the factors associated with FBSA use by considering socio-demographic, health (e.g., chronic diseases), orthorexia, dietary (i.e., diet, food choice motives) and emotional (i.e., health anxiety, emotional competence) characteristics. To achieve this goal, three levels of analysis were conducted. The first compares the characteristics examined between FBSA users and non-users; the second determines the association between duration and frequency of FBSA use and the FBSAQ subdimensions (i.e., pathological use, food preoccupation, exclusion of unhealthy components); the third explores the relationship between FBSAQ subscale scores and orthorexia, food choice motives and emotions. We hypothesized that:

H1. FBSA users will have higher scores on the TOS “OrNe” and “HeOr” subscales, the FCQ “health”, “natural content” and “weight control” subscales and all HAQ subscales compared with FBSA non-users. Conversely, FBSA users should have lower scores than non-users on the PEC subscales.

H2. FBSA users are expected to be indistinguishable on the FBSAQ and TOS subscales regardless of the duration of application use. However, participants using FBSA several times a week should obtain higher scores on all FBSAQ and TOS subscales than users using them less than once a month.

H3. The FBSAQ subscales should be positively and strongly correlated with TOS “OrNe” subscale, FCQ “health”, “natural content” and “weight

control” subscales, as well as with all HAQ subscales. We expect positive but weaker correlations between the dimensions of the FBSAQ and the TOS “HeOr” subscale and FCQ “health”, “natural content” and “weight control” subscales. Negative correlations should also be observed between the FBSAQ subscales and the emotional competence subscales.

2. Method

2.1. Participants and procedure

Participants were recruited between May 2021 and May 2023 through calls for participation posted on social networks (e.g., Facebook® groups, LinkedIn®, Reddit®) and forums, street canvassing, posters in private places (e.g., building entrances, health centers), and by using the researchers' social networks.

Before completing the questionnaires on the LimeSurvey® platform, participants were required to read the information note to verify the inclusion criteria (i.e., aged 18 to 65, fluent in French, and female participants not pregnant), and provide informed consent. The research protocol was approved by the research ethics committee of the University (N°2020–97).

A total of 2074 participants were recruited: 84.76 % through indirect solicitation (i.e., social networks, forums, posters), 14.13 % through direct solicitation (i.e., researchers' social networks, mail, street canvassing, word of mouth) and 1.11 % did not specify how they knew about the study. However, male respondents were excluded due to their small number ($n = 56$ for FBSA users; and $n = 345$ for FBSA non-users) and some female respondents were excluded due to missing or outlying socio-demographic data ($n = 63$). The final sample comprise 1610 French women, 18.68 % of whom reported currently using at least one FBSA.

2.2. Measures

2.2.1. Socio-demographic and health factors

An ad hoc questionnaire was developed to collect data regarding socio-demography (e.g., age, marital status [single/in couple], academic background [from *no diploma* to *PhD*]) and health (e.g., chronic disease [yes/no]). Data regarding height and weight was collected to calculate the current body mass index (BMI) and ponderal index of respondents, but also minimal and maximum lifetime weight to calculate lower and higher BMI data.

Participants were also asked about their use of health apps. They were asked to select the types of applications they used from a list (e.g., pedometer, diet, FBSA). If participants reported using an FBSA, they were asked about the duration [less than six months/between six months and one year/for over one year] and frequency of their use [less than once a month/several times a month/several times a week].

2.2.2. Food Frequency Questionnaire (FFQ)

The FFQ was conceptualised by Thompson and Byers (1994) to assess the frequency of food consumption over periods ranging from 24 h to one year. For this study, the FFQ was comprised of 14 items investigating the frequency of consumption of animal products, fruits and vegetables, cereals and legumes, processed products, and fats. Over a one-week period, participants were asked to indicate how often they consumed these foods, using a 5-point Likert scale (from 0: *never* to 4: *every day*). Based on the analysis of these results, the participants' diet was defined as “omnivorous”, “partial vegetarian”, “strict vegetarian”, or “vegan” (Hanras et al., 2022).

2.2.3. Food Barcode Scanner App Questionnaire (FBSAQ)

The FBSAQ (Hanras et al., 2024) measures FSBA usage through three factors: pathological use (5 items; e.g., *I can't help but scan the products I consume*; $\omega = 0.92$; all reported McDonald's omega coefficient corresponding to the current sample), food preoccupation (6 items; e.g., *I use*

Table 1
Descriptive statistics and group comparisons for sociodemographic, health, and diet data according to FBSA use ($N = 1610$).

	Non-users	Users	Comparisons		
	($n = 1222$)	($n = 388$)	χ^2/t	p	V/d
Age, Mean (SD)	37.56 (12.89)	36.40 (12.76)	1.55	0.121	0.09
Marital Status, % (ASR)			5.07	0.024	0.06
Single	34.7 (0.92)	28.4 (-1.65)			
In couple	65.3 (-0.65)	71.6 (1.16)			
Having child, % (ASR)			0.01	0.912	0.00
Yes	47.7 (-0.06)	48.2 (0.11)			
No	52.3 (0.06)	51.8 (-0.10)			
Academic degree, % (ASR)			1.19	0.551	0.03
<Bachelor	8.7 (-0.28)	9.0 (0.48)			
Bachelor	18.4 (0.55)	16.0 (-0.96)			
>Bachelor	72.9 (-0.17)	75.0 (0.30)			
Professional status, % (ASR)			5.49	0.241	0.06
Student	17.6 (-1.03)	22.7 (1.80)			
Employed	64.4 (0.38)	60.8 (-0.66)			
Sick leave	4.6 (0.34)	3.9 (-0.59)			
Unemployed	9.8 (0.03)	9.8 (-0.06)			
Retired	3.6 (0.36)	2.8 (-0.63)			
Healthcare visit frequency, % (ASR)			18.90	<0.001	0.11
Several times a month	2.0 (-1.02)	3.9 (1.83)			
At least once a month	10.6 (-1.62)	17.3 (2.87)			
At least once a year	73.0 (0.52)	67.8 (-0.92)			
Less than once a year	14.5 (0.77)	11.1 (-1.38)			
Chronic disease, % (ASR)			0.14	0.707	0.01
Yes	20.4 (0.20)	19.3 (-0.35)			
No	79.6 (-0.10)	80.7 (0.18)			
BMI, Mean (SD)					
Current BMI	24.52 (6.04)	24.45 (5.95)	0.19	0.853	0.01
Lifetime lowest BMI	20.24 (3.87)	20.33 (3.55)	-0.42	0.676	0.02
Lifetime highest BMI	27.34 (7.21)	26.84 (6.94)	1.21	0.226	0.07
Ponderal index, % (ASR)			2.44	0.486	0.04
Underweight	8.8 (0.09)	8.5 (-0.17)			
Normal	54.8 (-0.33)	57.7 (0.58)			
Overweight	21.0 (0.66)	17.5 (-1.17)			
Obesity	15.3 (0.20)	16.2 (0.35)			
Diet, % (ASR)				0.656	0.04
Omnivore	67.7 (-0.30)	70.6 (0.53)			
Partial vegetarian	19.0 (0.34)	17.3 (-0.60)			
Strict vegetarian	13.0 (0.21)	12.1 (-0.38)			
Vegan	0.3 (0.55)	0.0 (-0.98)			

Note: For "Diet", a Fisher exact test was calculated with V of Cramer. Bold values represent the significant results.

Legend: ASR: Adjusted Standardized Residuals; BMI: Body Mass Index; d : Cohen's d ; SD: Standard Deviation; V: V of Cramer.

the app because I am wary of processed products; $\omega = 0.83$), and exclusion of unhealthy components (3 items; e.g., *Since I started using the app, I have excluded products that are too salty*; $\omega = 0.84$). The scale, only presented to participants who reported currently using an FSBA, consists of 14 items rated on a 5-point Likert scale (from 1: *totally disagree* to 5: *totally agree*).

2.2.4. Teruel Orthorexia Scale (TOS)

The TOS (Barrada & Roncero, 2018; Maïano et al., 2022 for the French-Canadian version) assesses the bidimensional conceptualisation of orthorexia through two factors: OrNe (8 items; e.g., *I feel overwhelmed or sad if I eat food that I consider unhealthy*; $\omega = 0.83$) and HeOr (9 items; e.g., *I mainly eat foods that I consider to be healthy*; $\omega = 0.86$). The scale consists of 17 items rated on a 4-point Likert scale (from 0: *strongly disagree* to 3: *strongly agree*).

2.2.5. Food Choice Questionnaire (FCQ)

The FCQ (Steptoe et al., 1995) measures nine food choice motives: convenience (5 items; e.g., *Is easy to prepare*; $\omega = 0.81$), natural content (3 items; e.g., *Contains no additives*; $\alpha = 0.83$), ethical concern (9 items for French version; e.g., *Has been produced in a way that animals' rights have been respected*; $\omega = 0.84$), weight control (3 items; e.g., *Is low in fat*; $\omega = 0.80$), sensory appeal (4 items; e.g., *Looks nice*; $\omega = 0.67$), price (3 items; e.g., *Is cheap*; $\omega = 0.82$), familiarity (3 items; e.g., *Is familiar*; $\omega = 0.75$), health (6 items; e.g., *Is nutritious*; $\omega = 0.83$), and mood (6 items; e.g.,

Cheers me up; $\omega = 0.84$). The French version (Hanras et al., 2022), including the ethical module from Lindeman and Väänänen (2000), consists of 39 items rated on a 4-point Likert scale (from 1: *not at all important* to 4: *very important*).

2.2.6. Health Anxiety Questionnaire (HAQ)

The HAQ (Lucock & Morley, 1996; Bridou, 2012 for the French version) assesses four dimensions of health anxiety: health worry and preoccupation (8 items; e.g., *Do you ever worry about your health?*; $\omega = 0.89$), fear of illness and death (7 items; e.g., *Do you ever feel afraid that you may die soon?*; $\omega = 0.89$), reassurance-seeking behaviour (3 items; e.g., *Do you ever examine your body to find whether there is something wrong?*; $\omega = 0.77$), and interference with life (3 items; e.g., *Do your bodily symptoms stop you from enjoying yourself?*; $\omega = 0.82$). A total score can also be calculated ($\alpha = 0.93$). The scale consists of 21 items rated on a 5-point Likert scale (from 1: *never* to 5: *most of the time*).

2.2.7. Profile of Emotional Competence (PEC)

The PEC (Brasseur et al., 2013) measures emotional competencies and comprises two subscales: intra-personal and inter-personal competencies. Only the intrapersonal emotional competencies subscale ($\omega = 0.89$) was used in this study, covering five dimensions: identification (5 items; e.g., *I am aware of my emotions as soon as they arise*; $\omega = 0.73$), comprehension (5 items; e.g., *I don't always understand why I respond in the way I do*; $\omega = 0.81$), expression (5 items; e.g., *I am good at describing*

Table 2
Descriptive statistics and group comparisons for orthorexia, dietary and emotional subscales according to FBSA use (N = 1610).

	Non-users	Users	Comparisons		
	(n = 1222)	(n = 388)	t	p	d
TOS					
Healthy orthorexia	12.72 (5.97)	13.71 (5.94)	-2.84	0.004	0.17
Orthorexia nervosa	5.34 (4.74)	5.57 (4.74)	-0.84	0.401	0.05
FCQ					
Convenience	3.06 (0.70)	3.08 (0.68)	-0.53	0.593	0.03
Natural content	3.03 (0.85)	3.19 (0.72)	-3.50	<0.001	0.20
Ethical concern	2.69 (0.79)	2.83 (0.70)	-3.22	0.001	0.19
Weight control	2.48 (0.89)	2.60 (0.82)	-2.46	0.014	0.14
Sensory appeal	3.29 (0.61)	3.25 (0.61)	1.07	0.286	0.06
Price	2.87 (0.77)	2.83 (0.75)	0.93	0.352	0.05
Familiarity	2.14 (0.81)	2.16 (0.81)	-0.42	0.677	0.02
Health	2.77 (0.71)	2.97 (0.64)	-4.91	<0.001	0.29
Mood	2.46 (0.78)	2.53 (0.76)	-1.43	0.154	0.08
HAQ					
Total score	47.34 (14.76)	51.41 (15.01)	-4.72	<0.001	0.27
Health worry and preoccupation	15.19 (6.31)	16.85 (6.64)	-4.46	<0.001	0.26
Fear of illness and death	15.96 (5.17)	17.32 (5.08)	-4.54	<0.001	0.26
Reassurance-seeking behaviour	9.66 (3.69)	10.58 (3.82)	-4.24	<0.001	0.25
Interference with life	6.53 (2.73)	6.65 (2.65)	-0.80	0.423	0.05
PEC					
Total score	3.27 (0.66)	3.22 (0.61)	1.32	0.185	0.08
Identification	3.52 (0.84)	3.45 (0.79)	1.59	0.112	0.09
Comprehension	3.26 (1.00)	3.11 (0.98)	2.56	0.010	0.15
Expression	3.24 (0.90)	3.18 (0.83)	1.21	0.226	0.07
Regulation	2.80 (0.91)	2.76 (0.85)	0.69	0.493	0.04
Utilisation	3.52 (0.78)	3.60 (0.75)	-1.71	0.087	0.10

Note: Bold values represent the significant results.

Legend: *d*: Cohen's *d*.

my feelings; $\omega = 0.70$), regulation (5 items; e.g., *When I am sad, I find it easy to cheer myself up*; $\omega = 0.78$), utilisation (5 items; e.g., *I use my feelings to improve my choices in life*; $\omega = 0.73$). The intra-personal emotional competencies subscale consists of 25 items rated on a 5-point Likert scale (from 1: *strongly disagree* to 5: *strongly agree*).

2.3. Statistical analysis

The statistical analysis was performed with R Studio (2023.03.1 + 446) software (RStudio Team, 2020). To test the first hypothesis, descriptive analysis was performed to obtain the frequency for categorical data (e.g., scanned food, marital status, diet) and the mean and standard deviation for continuous data (i.e., age, BMI, subscales scores). Next, Chi-square tests were calculated to compare categorical variables between FBSA users and non-users. Adjusted standardized residuals (an absolute value > 2 indicated a significant over- or under-representation) and *V* of Cramer are reported. For diet, however, a Fisher exact test and *V* of Cramer were used due to the low number of vegans. Student *t*-tests for independent groups with Cohen's *d* were also performed to compare continuous data across groups (i.e., FBSA users/non-users).

Then, statistical analyses were only conducted among FBSA users. Before testing hypothesis 2, we performed a Chi-square test with *V* of Cramer to verify that there was no difference between the frequency and duration of use of FBSA. Then, the FBSAQ subscales scores and the TOS subscale scores were compared as a function of a) the duration of FBSA use and b) the frequency of FBSA use using one-way ANOVAs. Eta squared was used as effect size and Cohen's *d* was used for Tukey pairwise comparisons. To test the third hypothesis, a correlation matrix was calculated between FBSAQ subscales scores and orthorexia, dietary and emotion subscales scores.

Effect sizes are to be interpreted differently when they are identified by *V* of Cramer, Cohen's *d* and eta squared. For the *V* of Cramer, it is necessary to consider the degrees of freedom in order to interpret it (Kim, 2017). For Cohen's *d*, the thresholds are as follows: small effect for $d = 0.20$, medium effect for $d = 0.50$ and large effect for $d = 0.80$ or more (Cohen, 1988). Finally, for the eta squared, the thresholds are as

follows: small effect for $\eta^2 = 0.01$, medium effect for $\eta^2 = 0.06$ and large effect for $\eta^2 = 0.14$ (Cohen, 1988).

3. Results

3.1. Test of hypothesis 1: comparison of FBSA users/non-users

The socio-demographic, health, and diet characteristics according to FBSA use are presented in Table 1. Two significant differences were observed. Regarding marital status, the Chi-square test was significant ($p = .024$, $V = 0.06$), but no the post hoc test (ASR). For the other significant difference, the results showed that FBSA users frequented healthcare professionals more frequently than non-users ($p < .001$, $V = 0.11$).

The descriptive statistics and group comparisons for the questionnaires according to FBSA use are presented in Table 2. FBSA users had significantly higher scores than non-users on the TOS "healthy orthorexia" subscale ($p = .004$, $d = 0.17$) and on the FCQ "natural content" ($p < .001$, $d = 0.20$), "ethical concern" ($p = .001$, $d = 0.19$), "weight control" ($p = .014$, $d = 0.14$), and "health" ($p < .001$, $d = 0.29$) subscales. Regarding emotional scales, users had significantly higher scores than non-users on HAQ total score ($p < .001$, $d = 0.27$) and "health worry and preoccupation" ($p < .001$, $d = 0.26$), "fear of illness and death" ($p < .001$, $d = 0.26$), and "reassurance-seeking behaviour" ($p < .001$, $d = 0.25$) subscales. Conversely, they had lower scores than non-users on the PEC "comprehension" subscale ($p = .010$, $d = 0.15$).

3.2. Test of hypothesis 2: comparison of FBSAQ scores and TOS scores according to both the duration and the frequency FBSA use

Before testing hypothesis 2, we would like to specify that no difference was observed between duration of FBSA use and frequency of FBSA use ($\chi^2(4) = 9.75$, $p = .370$, $V = 0.09$). The results of comparison of FBSAQ and TOS subscales according a) the duration of FBSA use and b) the frequency FBSA use are presented in Table 3.

First, significant differences were observed for the FBSAQ "food

Table 3
Descriptive and comparative statistics of FBSAQ and TOS subscales scores by the duration and the frequency of FBSA use (n = 388).

Duration of FBSA use	A. Less than six months	B. Between six months and a year	C. For over a year	Comparisons			Post hoc
	(n = 37)	(n = 51)	(n = 300)	F	p	η ²	
FBSAQ							
Pathological use	1.73 (0.85)	1.75 (0.89)	1.98 (1.11)	1.76	0.174	0.00	–
Food preoccupation	3.08 (1.19)	3.39 (0.97)	3.63 (0.89)	6.64	0.001	0.03	C > A
Exclusion of unhealthy components	2.37 (1.16)	2.30 (1.06)	2.65 (1.16)	2.69	0.069	0.01	–
TOS							
Orthorexia nervosa	5.41 (5.12)	4.51 (4.20)	5.78 (4.77)	1.59	0.206	0.00	–
Healthy orthorexia	13.05 (6.30)	10.80 (5.30)	14.29 (5.86)	8.02	<0.001	0.04	C > B
Frequency of FBSA use							
	A. Several times a week	B. Several times a month	C. Less than once a month	Comparisons			Post hoc
	(n = 65)	(n = 143)	(n = 180)	F	p	η ²	
FBSAQ							
Pathological use	3.07 (1.15)	2.09 (1.03)	1.39 (0.59)	91.24	<0.001	0.32	A > B > C
Food preoccupation	4.16 (0.76)	3.79 (0.77)	3.13 (0.95)	43.84	<0.001	0.19	A > B > C
Exclusion of unhealthy components	3.35 (1.15)	2.79 (1.11)	2.13 (0.99)	35.92	<0.001	0.16	A > B > C
TOS							
Orthorexia nervosa	6.95 (5.32)	5.16 (3.98)	4.41 (5.00)	3.46	0.033	0.02	A > C
Healthy orthorexia	15.77 (5.77)	14.24 (5.89)	12.55 (5.79)	8.19	<0.001	0.04	A, B > C

Note: Bold values represent the significant results.
Legend: η²: Eta-squared.

Table 4
Correlation matrix between FBSAQ subscales scores and orthorexia, dietary, and emotional dimensions among FBSA users (n = 388).

	Descriptives	Correlations		
	Mean (SD)	Pathological use	Food preoccupation	Exclusion of unhealthy components
FBSAQ				
Pathological use	1.93 (1.06)	–		
Food preoccupation	3.55 (0.95)	0.56***		
Exclusion of unhealthy components	2.58 (1.16)	0.59***	0.62***	–
TOS				
Healthy orthorexia	13.71 (5.94)	0.29***	0.47***	0.39***
Orthorexia nervosa	5.57 (4.74)	0.20***	0.15**	0.19***
FCQ				
Convenience	3.08 (0.68)	–0.01	–0.05	–0.01
Naturel content	3.19 (0.72)	0.28***	0.53***	0.40***
Ethical concern	2.83 (0.70)	0.16**	0.32***	0.22***
Weight control	2.60 (0.82)	0.20***	0.17***	0.38***
Sensory appeal	3.25 (0.61)	–0.05	–0.02	0.08
Price	2.83 (0.75)	0.11*	–0.03	0.06
Familiarity	2.16 (0.81)	0.02	–0.10	0.00
Health	2.97 (0.64)	0.28***	0.35***	0.36***
Mood	2.53 (0.76)	0.15**	0.07	0.11*
HAQ				
Total score	51.41 (15.01)	0.12*	0.06	0.01
Health worry and preoccupation	16.85 (6.64)	0.12*	0.06	0.02
Fear of illness and death	17.32 (5.08)	0.09	0.05	0.02
Reassurance-seeking behaviour	10.58 (3.82)	0.11*	0.06	–0.02
Interference with life	6.65 (2.65)	0.03	0.01	–0.02
PEC				
Total score	3.22 (0.61)	0.03	0.15**	0.08
Identification	3.45 (0.79)	0.06	0.14**	0.10
Comprehension	3.11 (0.98)	–0.02	0.09	0.01
Expression	3.18 (0.83)	0.02	0.04	0.03
Regulation	2.76 (0.85)	0.07	0.09	0.05
Utilisation	3.60 (0.75)	0.01	0.19***	0.10*

Legend: SD: Standard Deviation.
* p < 0.05.
** p < 0.01.
*** p < 0.001.

preoccupation” subscale [F(2,385) = 6.64, p = .001, η² = 0.03] and the TOS “healthy orthorexia” subscale [F(2,385) = 8.02, p < .001, η² = 0.04]. More specifically, users who have been using FBSA for more than one year obtained higher scores than those who had been using FBSA for less than six months on the FBSAQ “food preoccupation” subscale (p =

.002, d = –0.59). Moreover, users who have been using FBSA for more than one year obtained higher scores than those who had been using FBSA between six months and one year on the TOS “healthy orthorexia” subscale (p < .001, d = –0.60).

Secondly, significant differences were observed with all FBSAQ

subscales ($\eta^2 = [0.16; 0.32]$) and with the two TOS subscales ($\eta^2 = 0.02$ for “orthorexia nervosa” and $\eta^2 = 0.04$ for “healthy orthorexia”). Participants using FBSA several times a week scored higher than those using them several times a month and those using them less than once a month on the FBSAQ “pathological use” ($p < .001$ for both post hoc, $d = -1.12$ and $d = -1.92$, respectively), “food preoccupation” ($p = .011$, $d = -0.43$ and $p < .001$, $d = -1.21$) and “exclusion of unhealthy components” ($p = .001$, $d = -0.53$ and $p < .001$, $d = -1.15$) subscales. Participants using FBSAs several times a week scored higher than those using them less than once a month on TOS “orthorexia nervosa” ($p = .030$, $d = -0.38$) and “healthy orthorexia” subscales ($p < .001$, $d = -0.55$). Finally, participants using FBSA several times a month scored higher than those using them less than once a month on the FBSAQ “pathological use” ($p < .001$, $d = -0.79$), “food preoccupation” ($p = .011$, $d = -0.77$) and “exclusion of unhealthy components” ($p = .001$, $d = -0.62$) subscales, and on TOS “healthy orthorexia” subscale ($p = .027$, $d = -0.29$).

3.3. Test of hypothesis 3: correlations between FBSAQ, orthorexia, dietary, and emotional dimensions

Correlation analyses of subscale scores, performed among FBSA users, are presented in Table 4. FBSAQ subscale scores (i.e., pathological use, food preoccupation, exclusion of unhealthy components) were significantly positively intercorrelated (from $r = 0.56$ to 0.62).

The three FBSAQ subscales were positively correlated with the TOS “healthy orthorexia” (from $r_s = 0.29$ to 0.47) and “orthorexia nervosa” (from $r_s = 0.15$ to 0.20) subscales scores, and with the FCQ “natural content” (from $r_s = 0.28$ to 0.53), “ethical concern” (from $r_s = 0.16$ to 0.32), “weight control” (from $r_s = 0.17$ to 0.38), and “health” (from $r_s = 0.28$ to 0.36) subscales scores. Only the “pathological use” and the “exclusion of unhealthy components” FBSAQ subscale scores were positively correlated on the FCQ “mood” subscale ($r = 0.15$ and $r = 0.11$, respectively).

Regarding emotional components, the “food preoccupation” and the “exclusion of unhealthy components” FBSAQ subscales were positively correlated with the PEC “utilisation” subscale ($r = 0.19$ and $r = 0.10$). Only the “food preoccupation” FBSAQ subscale was positively correlated with the PEC total ($r = 0.15$) and “identification” subscale ($r = 0.14$) scores. Moreover, only the “pathological use” FBSAQ subscale score was positively correlated with the HAQ total ($r = 0.12$), “health worry and preoccupation” ($r = 0.12$) and “reassurance-seeking behaviour” ($r = 0.11$) subscale scores.

4. Discussion

FBSA use has been little studied, although these apps are widely used (IFOP, 2019; OpinionWay, 2019), and their use may be deleterious for some individuals (Hanras et al., 2024). It has even been suggested that FBSA use may be symptomatological of OrNe (Hanras et al., 2023; Lecerf, 2019). However, no study has tested this hypothesis. From a preliminary study, the main aim of this study was, therefore, to examine the relationship between FBSA use and orthorexia, diet, and emotions.

The comparative approach used in this study revealed that FBSA users did not differ from non-users in terms of socio-demographic and health data (consistent with the findings of Hanras et al., 2024). However, FBSA users visited a healthcare professional more regularly and had more health-related concerns than non-users. Contrary to our hypothesis 1, these health-related concerns do not appear to be pathological in nature, as FBSA users did not differ from non-users on the “interference with daily life” subscale. It is, therefore, possible that this health anxiety is beneficial. On the one hand, it encourages users to visit healthcare professionals frequently. On the other hand, health anxiety may be a sign of healthy thinking and support the adoption of health-promoting behaviours (Bridou & Aguerre, 2012).

Among FBSA users, the adoption of health-promoting behaviours could be expressed in particular through their motivations for food

choices. Indeed, according to our hypothesis 1, results showed that users were more motivated by natural content, health and ethical concerns in their food choices than non-users. In some FCQ validation studies, the natural content and health factors were merged (Depa et al., 2019; Dowd & Burke, 2013; Fotopoulos et al., 2009; Milošević et al., 2012). Thus, Dowd and Burke (2013) found that the factors “natural content and health” and “ethical concerns” alone predicted the intention to buy sustainably sourced food. Similarly, the study by Hanras et al. (2024) found that FBSA users consumed more organic food than non-users.

Furthermore, according to our hypothesis 1, the results showed that FBSA users were also more motivated by the possibility of controlling their weight than non-users. This motivation is associated with a healthy food choice motive (Pieniak et al., 2009), since excessive weight and obesity are associated with the emergence of somatic difficulties and chronic diseases (Consultation on Obesity, 2003; Guh et al., 2009; Pischon & Nimptsch, 2016; Schlienger et al., 2009). Thus, the desire to control weight found among FBSA users may be part of a desire to stay healthy rather than a real desire to lose weight. These results are partly corroborated by associations with the orthorexia scale. Indeed, FBSA users scored higher on the HeOr, but not on the OrNe, subscale. Many researchers think that OrNe should be considered an eating disorder (e.g., Donini et al., 2023). OrNe is indeed associated with a desire to lose weight (Barthels et al., 2019; Depa et al., 2019) as well as concerns about body image (e.g., Chace & Kluck, 2022; Lason et al., 2023) – which is not the case for HeOr. It is, therefore, possible that the use of FBSA is purely linked to a desire to stay healthy, with a focus on controlling ultra-processed products (i.e., vacuum-packed food).

The results also showed that scores on the three FBSAQ subscales (i.e., pathological use, food preoccupation, exclusion of unhealthy components) were positively correlated with food choice motives related to natural content, health, weight control and ethical concerns, but also with HeOr and OrNe scores. These results are partly in line with our hypothesis 3, but the strengths of the correlations are much weaker than we had assumed. Although no differences in OrNe scores were observed according to FBSA use (contrary to our hypothesis 1), it is noteworthy that some dimensions by the FBSAQ are weakly associated with higher OrNe scores. These associations were expected insofar as OrNe is associated with health concerns (Barthels et al., 2021; Chace & Kluck, 2022; Gajdos et al., 2021; Greville-Harris et al., 2022; Kiss-Leizer et al., 2019; Tóth-Király et al., 2021) as well as a need to control food quality (Barthels et al., 2024; Hanras et al., 2023). Conversely, the association between HeOr and problematic use of FBSA could be explained by the moderate correlation between OrNe and HeOr scores (widely reported in the literature [Barrada & Roncero, 2018; Lason et al., 2023]). This hypothesis needs to be tested empirically, and further studies are needed to determine the causal relationship between FBSA use and the development of OrNe. It is possible that some individuals turn to FBSAs because they already have symptoms of OrNe (as in the case-control study by Barthels et al., 2024). However, the reverse is also likely; FBSA use could promote the development or maintenance of OrNe.

While the study by Hanras et al. (2024) showed that the FBSAQ “pathological use” subscale was associated with chronic illness and a higher frequency of healthcare visit, the results show that the scores on this subscale are also weakly positively associated with health anxiety, in particular with the HAQ “health worry and preoccupation” and “reassurance-seeking behaviour” subscales. These results are partly in line with our hypothesis 3, but the strengths of the correlations are much weaker than we had assumed. It is possible that in highly anxious individuals, the compulsive use of FBSAs (observed with “pathological use” subscale of FBSAQ, but also with frequency of FBSA use) helps to regulate health concerns. Indeed, FBSA use could be part of a reassurance-seeking behaviour in which all food intake is controlled in order to stay healthy. It is also possible that this association may explain the difference observed in health anxiety scores and frequency of medical consultations between FBSA users and non-users. Care should, therefore, be taken with people suffering from health anxiety, as they

may develop problematic FBSA use. Moreover, as previously reported (Hanras et al., 2024), the frequency of FBSA use is closely linked to FBSAQ “pathological use” subscale (according to our hypothesis 2). It is therefore possible that people who scan food every time or almost every time are unable to control their use of the app and thus lose their spontaneous relationship with food.

For the FBSAQ “food preoccupations” and “exclusion of unhealthy components” subscales, it was observed that the participants' scores were weakly positively correlated with the use of emotions. This adapted use of emotions can be expressed both in a distrust of the components of industrial products (i.e., “food preoccupations” factor), leading to hyper-selection of foods, and, therefore, to the consumption of healthier foods (i.e., “exclusion of unhealthy components” factor). Indeed, individuals with high scores on these factors tend to avoid foods containing excessive additives, sugar, salt and fat. As a result, they are more likely to choose foods based on their natural and health-promoting content. Thus, the FBSAQ “food preoccupations” and “exclusion of unhealthy components” subscales appear to be healthy since they encourage the adoption of a healthier diet. However, further studies are needed to better identify what distinguishes healthy from pathological FBSA use beyond the emotional dimensions.

5. Limitations

The results of this study should be interpreted with caution in light of its limitations. First of all, this study was only conducted with women. Although this enabled us to obtain a large sample of female FBSA users and control for the effect of gender, it is necessary to investigate FBSA use among men as well. Indeed, motivations for using these apps, as well as the risk factors for developing pathological use, could be different in men. The gender imbalance may be a consequence of the participant recruitment methods. Indeed, the majority was recruited from Facebook® groups dedicated to health and diet to reach FBSA users. However, women are more likely to participate in studies in psychology and/or eating behaviours than men. Although other recruitment methods were used (e.g., street canvassing, posters in building entrances), the primary method may have influenced the results. Secondly, despite the large sample size, it should be noted that the effect sizes obtained are relatively small. Further studies are therefore needed to confirm these results. Finally, the internal consistency of some subscales was weak (e.g., “expression” PEC subscale and “sensory appeal” FCQ subscale). The results of these subscales should, therefore, be interpreted with caution.

6. Perspectives and implications

Although this study sheds important light on the FBSA use, further studies are needed. To better understand the interaction between orthorexia symptoms and problematic FBSA use, a mixed-method longitudinal study should be conducted. On the one hand, such research would make it possible to assess why some people develop problematic FBSA use and to identify factors favouring such problematic use. Participants' feelings and perceptions of the transition from healthy to problematic FBSA use, if any, could be captured. Risk factors for problematic use could be identified. On the other hand, research of this magnitude would enable the intra-personal characteristics that promote or reinforce OrNe symptoms to be evaluated. If orthorexia was considered through a prism ranging from the normal to the pathological (Silva et al., 2022), transition factors from HeOr to OrNe could also be identified.

The FBSA research area alerts healthcare professionals (e.g., physicians, psychologists, nutritionists) to the difficulties associated with FBSA use. Clinicians can quickly assess their patients' FBSA use with FBSAQ, for example, and if necessary, initiate work on any problematic use. Our data suggests that health concerns were an important determinant of use, whether or not FBSA use is associated with OrNe.

Furthermore, in the case of OrNe, clinicians can work with their patients on the use of FBSA in food choices, with the aim of enabling a return to less stressful, more spontaneous eating.

7. Conclusion

This study shows that FBSA women users differ from non-users in terms of orthorexia, food choice motives and emotional dimensions. On the one hand, users are more motivated by natural content and healthy foods in their food choices than non-users, and have higher scores for healthy orthorexia. On the other hand, health-related concerns were found to be more pronounced among food barcode scanner apps users, suggesting that the use of these apps may contribute to the regulation of health-related concerns. These concerns, as well as orthorexia nervosa, appeared to be related to participants' difficulties in freeing themselves from the use of food barcode scanner apps. Healthcare professionals (e.g., physicians, nutritionists, dieticians) need to be vigilant of their patients who use apps, especially if they present with health-related anxiety or orthorexic symptoms, as this poses a risk for pathological use.

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CRediT authorship contribution statement

Eva Hanras: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Emilie Boujut:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Conceptualization. **Géraldine Dorard:** Writing – review & editing, Visualization, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

Availability of data

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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