Abstract

The association between family environment and child’s eating behaviors is well established but a multidimensional approach to study this relation is lacking. This study aimed to assess the proprieties of a questionnaire created to evaluate parental practices, preferences, skills and attitudes regarding fruit and vegetables (F&V), sugar and salt. Participants (n = 714) were families of pre-school children (aged 2–6 years old) of the Nutriscience Project—a web-based gamification program—who answered a questionnaire assessing socio-demographic characteristics, nutrition knowledge, and a scale evaluating parental practices, preferences, skills and attitudes, at the baseline of the project. Exploratory factorial analysis was applied to the scale: 21 items and 5 factors were extracted (52.4% of explained variance) with a Kaiser-Meyer-Olkin (KMO) value of 0.770: 1. Modelling/active promotion of F&V consumption (α = 0.73), 2. Skills for choosing/preparing healthy food (α = 0.75), 3. Food preferences and satiety perception (α = 0.70), 4. Awareness regarding sugar/salt intake (α = 0.61), 5. Allowance regarding F&V consumption (α = 0.55). Kruskal-Wallis and Mann-Whitney tests were conducted to compare factors according to socio-demographic characteristics. Higher scores for parental modelling and active promotion of F&V consumption were observed in older parents, those with higher nutrition knowledge and who reported to live without income difficulties. Regarding food preferences, higher scores were observed in mothers, with higher nutrition knowledge and from higher educated groups. Higher awareness regarding salt and sugar consumption were observed in older parents, with higher education, higher nutrition knowledge and with female children. Older parents and with female children also registered higher scores of skills for choosing/preparing healthy food. The scale showed satisfactory proprieties and may contribute to assess family food environment using a multidimensional approach. It also highlighted the importance of considering socio-demographic characteristics in interventions to promote healthy eating.
Introduction

An unhealthy diet is considered one of the most important lifestyle risk factors for Noncommunicable Diseases (NCD), which are the main cause of mortality worldwide [1]. The World Health Organization (WHO) considers that reducing salt and sugar intake and increasing fruit and vegetables (F&V) consumption must be priority areas for the promotion of a healthier diet. Several authors revealed that children and adolescents do not meet WHO recommendations for sugar, salt and F&V intake. According to Crowe, O’Sullivan [2], in Ireland, 75% of children aged 3-years old do not meet WHO recommendations for free sugars (<5% of total energy value) and according to Marinho, Severo [3], the lower adherence of free sugars recommendations were in children (51.6%) and adolescents (51.3%). A recent National Food Survey in Portugal, showed that 72% of children and 78% of adolescents do not meet the recommendations of F&V ≥400g/day [4]. According to Gonçalves, Abreu [5], 83% of a Portuguese sample of adolescents had a sodium intake above the upper limit recommended by WHO (2000 mg/day).

Parents have the main responsibility for their child’s eating behaviors [6] which should be early modulated [7, 8], in order to reverse the diet-related NCD growing trend.

Literature suggests that there are associations between family’s food environment and children’s energy-balance related behaviors [9–11]. Several studies showed a consistent positive association between parents’ and child consumption, regarding F&V [12–15], sweet beverages [16] and snacks with high energy value [17]. This association could also be related to home food availability [18–20]. Choosing which foods to buy, is very complex and a decision involves a lot of processes and dimensions (emotional, rational, social, e.g.). Identified this paradigm, this issue has been widely studied from different perspectives due to its complexity. There are studies focusing on socio-demographic characteristics [21, 22], personality/intrinsic characteristics [23, 24], and individual health beliefs, knowledge and skills [25–29]. The importance of consumer’s beliefs and perception is emphasized by the example of frozen versus fresh vegetables. Haynes-Maslow, Parsons [30] demonstrates that, despite the convenience, longer expiration date and similar nutritional value, consumers tend to choose fresh vegetables instead of frozen vegetables. This seems to be due to an intrinsic preference for natural, instead of transformed foods [31]. Besides preferences, Vidgen and Gallegos [25] describes how knowledge and skills interacts with attitudes and behaviors by introducing the concept of nutrition literacy. Nutrition literacy have been described as a powerful allied for healthier eating habits promotion and reveals the importance of having the know-how to appropriately plan and manage meals, select foods, prepare meals and eat.

Considering the diversity of factors described as determinants of eating habits, there are different instruments assessing parental and family’s practices/behaviors related to child’s food consumption using different approaches [32–38]. The diversity of dimensions and determinants of healthy eating highlights the need for a comprehensive and multilevel approach. However, a comprehensive and complete evaluation typically implies higher complexity and extent of the instrument. This may translate into a disadvantage. This study aimed to develop a short and easily interpretable instrument named “The multidimensional parental scale to assess determinants regarding F&V, sugar and salt”, focusing on the main topics for healthy eating promotion—F&V, sugar and salt as recommended, combining a broad range of parental dimensions: practices, skills and attitudes (framed in the concept of nutrition literacy) and food preferences considering: 1. their recognized value as a powerful predictor of food choice and eating habits and 2. the fact that they could be modulated during lifetime. Items focused mainly on parental food preferences, awareness regarding child’s sugar and salt intake, parental ability to promote F&V consumption, to select low-sugar and low-salt products, to prepare meals with F&V and low salt content, and to manage meals were evaluated in the questionnaire.
The objectives of this study were to 1. characterize the main properties of a new tool developed to assess parental practices, preferences, skills and attitudes regarding F&V, sugar and salt and 2. to characterize them according to socio-demographic characteristics and nutrition knowledge of pre-school children's parents.

**Material and methods**

The Nutriscience Project: Play, Cook and Learn was a web-based gamification intervention, aimed to evaluate and improve parental nutrition literacy (knowledge, practices, skills and attitudes regarding F&V, sugar and salt) and food preferences of children's aged 2–6 years old belonging to a national network of kindergartens, Santas Casas da Misericórdia of Portugal.

The intervention model of Nutriscience project consisted of a web-based gamification platform developed as a social network environment where schools and families signed up for membership [39]. In this study only baseline data was used for analysis.

**Sample and recruitment**

A convenience non-random sample of 37 kindergartens were invited to participate in the program, from those 32 were allocated to intervention group and 5 to the control group, targeting a minimum of 1 kindergarten from each administrative region of Portugal. All the families of pre-school children were invited to participate in this project through the participating kindergartens. Explanations on how to participate and access to the platform were provided in three regional meetings with educators and school directors. In addition, an introductory video and a power point presentation was given to educators to present at parents’ meetings and a pamphlet was distributed to all the eligible parents through the kindergartens.

The project was approved by the Ethics Committee of University of Porto and by the National Commission for Data Protection (CNPD). Informed consent indicating agreement of the parents to participate in this study was also requested before inclusion.

**Instrument development for parental practices, preferences, skills and attitudes evaluation**

To assess parents' practices, preferences, skills and attitudes on children's food consumption, a parental self-reported questionnaire was applied, which was filled out on the Nutriscience online platform. For the control group, a paper-based version of the questionnaire was handed out and returned through the kindergartens. The questionnaires were administered before and after the intervention (3 month period), assessing 1) socio-demographic characteristics (respondent’s age and degree of kinship to the child; number of household members; household classification (monoparental, couple with children or households with other members); number of household children; sex and age of participant child; education level, job situation and type of work’s institution of the respondent; income perception; food insecurity level, considering as a situation where difficulties related to access to food due to a socioeconomic factor were reported [40]), 2) nutrition knowledge [39], and 3) parental practices, preferences, skills and attitudes regarding F&V, sugar and salt. A pre-test was conducted in a sample of 10 families with 2–6 years-old children, in order to evaluate the time taken to fill up the questionnaire and the common understanding and interpretation of the questions. Based on the results obtained in the pre-test, minor changes were made to improve the clarity of the questionnaire.

For nutrition knowledge assessment, an adapted version of Nutrition Literacy Assessment Instrument (NLAI), published by the Centers of Disease Control and Prevention was used [41]. The adaption of the NLAI was performed regarding to the following aspects: 1) Translation and back-translation; 2) Portuguese food habits; 3) Portuguese food guide (Food Wheel);
4) The 3 major topics of the project namely a) promoting the consumption of F&V; b) reducing the intake of sugar and c) salt. A total of 20 multiple response questions covering 4 different dimensions: Nutrients (6 items), Food Portions (3 items), Portuguese Food Wheel Guide Groups (7 items), and Food Labeling (4 items) were evaluated.

Regarding parents’ practices, preferences, skills and attitudes, a Likert scale from 1 to 5 points was used for each item (1 – Completely disagree to 5 – Completely agree). Participants could also select the option “Do not want to answer”. Items from questionnaires addressed in European populations (EPODE for the Promotion of Health Equity (EPHE) [42], PRO-GREENS [11] (updated version of Energy parent and child questionnaire) and the EuropeaN Energy balance Research to prevent excessive weight Gain among Youth (ENERGY) questionnaire [10] were translated and adapted. Other items were developed according to the project main food topics and objectives. For items selection, some dimensions were draw apriori according to the project’s objectives focusing on parental active encouragement of child’s F&V consumption, parental allowance of child’s F&V consumption, parental self-efficacy to manage child’s intake, parental practices conducting energy-balance related behavior together with the child, parental food preferences and satiety perception, parental skills for choosing/preparing healthy food and parental awareness regarding child’s salt and sugar intake. Items were grouped in dimensions according to Exploratory Factorial Analysis procedures, as described below.

**Statistical analysis**

**Data preparation and participants’ characterization.** Statistical analysis was performed using IBM SPSS Statistics v25. This study analysis included only cases who declared that participant children was aged 2–6 years old and whose questionnaires were fulfilled by parents (mother or father). Regarding parents’ practices, preferences, skills and attitudes on child’s food consumption, only cases of individuals who answered all items were considered for the respective analysis (N = 618).

In order to analyze the data, the items “Vegetables do not satiate me”, “Fruit does not satiate me”, “Food without salt has no taste” and “I like the sweet beverages taste” were recoded through the inversion of the Likert Scale (5 – Totally disagree; 1 – Totally agree). Considering nutrition knowledge and food insecurity level scores, individuals who indicated “do not want to answer” were considered missing. Socio-demographic characteristics and nutrition knowledge were compared between participants who answered the questionnaire on paper or online according to Chi-Square test.

**Exploratory factorial analysis: Instrument characterization.** Regarding parents’ practices, preferences, skills and attitudes on children’s food consumption, Exploratory Factorial Analysis was used to reduce information’s complexity by extraction of different factors. The method of Principal Components and the Varimax rotation was used. Exploratory Factorial Analysis procedures were conducted for all items of the scale (n = 22). Items were included if factorial loadings and communalities’ values were > 0.3 and > 0.5, respectively. Three criteria were used to determine the number of factors to retain: — Eigenvalues higher than one; —Scree plot observation; — Interpretability (including items within the same concept). Internal reliability (Cronbach’s alpha coefficient) was calculated and factors were constructed if Cronbach’s alpha coefficient was acceptable (≥ 0.6) [43]. Thus, both Kaiser-Meyer-Olkin (KMO) and communalities values, total explained variance of the model and interpretability were important determinants for factors’ extraction and to determine which items were included in the model. Particularly, interpretability assumed a crucial importance considering that further analysis and results’ interpretation were based on those factors.

Values of means and standard deviation (SD) of items were used to factors’ description.
Characterization of parents’ food practices, preferences, skills and attitudes on child’s food consumption. For studying the factors (extracted by the Exploratory Factorial Analysis) according to socio-demographic characteristics, nutrition knowledge and method of data collection (paper or online), Mann-Whitney and Kruskal-Wallis tests were performed, as applicable. For Kruskal-Wallis’s multiple comparisons, Stepwise-Stepdown comparisons were used, and the Mann-Whitney test was used to describe which groups were significantly different on each factor. A significance value of 0.05 was considered. Means and SD were used to describe the observed differences of factors according to socio-demographic characteristics, nutrition knowledge and method of data collection.

Results
Socio-demographic characterization
Table 1 summarizes the socio-demographic characteristics of the participant families. A total of 723 participants fulfilled the baseline questionnaire and a total of 714 families were eligible for this study.

According to Table 1, most questionnaires were completed by mothers (82.6%), aged between 30 and 40 years old (71.9%), and highly educated (53.6%). About parent’s job situation, 84.6% of parents were employed or doing a paid activity. Related to income perception, most families reported to live without difficulties (73.6%) and approximately half of families (49.5%) had 3 or less members in their household. Regarding household characteristics, most families were constituted by both parents (82.6%) with an only child (52.6%). With regard to child’s age and sex, approximately half, were aged 4 years or older (54.9%) and female (47.9%).

A minority of families (22.5%) reported to live in a situation of food insecurity (modest, moderated or severe level). Considering families’ baseline nutrition knowledge evaluation, most parents answered correctly, at least, half of the questions (84.1%).

Regarding socio-demographic characteristics, the proportion of respondents who were fathers and, parents that reported food insecurity were higher among those who completed the online questionnaire (p = 0.001). Regarding job situation the proportion of participants who reported to be unemployed were higher among those who completed the questionnaire on paper (p = 0.001). For the other socio-demographic characteristics and for nutrition knowledge, not statistically differences were found (Table 1).

Exploratory factorial analysis: Instrument characterization
After conducting Exploratory Factorial Analysis for the 22 items scale of parents’ practices, preferences, skills and attitudes on child’s food consumption, a total of 7 factors were extracted with major conceptual inconsistencies. After that, the Scree Plot was observed and suggested 5 factors extraction. Conceptual meaning was achieved for 5 fixed factors with a total of 21 items, Kaiser-Meyer-Olkin value of 0.770, Barttlet sphericity test was rejected (p < 0.001) and an explained variance of 52.4% was observed.

Internal reliability was observed for each factor and dimensions were constructed by the mean average of items who integrated the factor (Table 2): 1. Parental modelling and active promotion of child’s F&V consumption (Reasonable Cronbach’s alpha: $\alpha = 0.73$), 2. Parental skills for choosing/preparing healthy food (Reasonable Cronbach’s alpha: $\alpha = 0.75$), 3. Parental food preferences and satiety perception (Reasonable Cronbach’s alpha: $\alpha = 0.70$), 4. Parental awareness regarding sugar and salt intake (Weak Cronbach’s alpha: $\alpha = 0.61$), and 5. Parental allowance regarding child’s F&V consumption (Weak Cronbach’s alpha: $\alpha = 0.55$). The item “I can prepare meals with frozen vegetables” was not considered in the model due to its low communality value and because it was not conceptually framed in the factor where it was projected.
Table 1. Socio-demographic characteristics and nutrition knowledge of participants.

|                                | Participants (n = 723) | Paper (n = 224) | Online (n = 499) | Significance value |
|--------------------------------|------------------------|-----------------|------------------|--------------------|
| **Respondent**                 |                        |                 |                  |                    |
| Mother                         | 597 (82.6)             | 204 (91.1)      | 393 (78.8)       | 0.001*             |
| Father                         | 117 (16.2)             | 20 (8.9)        | 97 (19.4)        |                    |
| Other                          | 9 (1.3)                | 0 (0.0)         | 9 (1.8)          |                    |
| **Respondent age (years)**     |                        |                 |                  |                    |
| <30                            | 74 (10.4)              | 22 (9.8)        | 52 (10.6)        | 0.138              |
| 30–40                          | 513 (71.9)             | 153 (68.3)      | 360 (73.6)       |                    |
| >40                            | 126 (17.7)             | 49 (21.9)       | 77 (15.7)        |                    |
| **Education level (schooling years)** |                        |                 |                  |                    |
| <10                            | 91 (12.7)              | 34 (15.2)       | 57 (11.6)        | 0.389              |
| 10–12                          | 240 (33.6)             | 71 (31.7)       | 169 (34.5)       |                    |
| >12                            | 383 (53.6)             | 119 (53.1)      | 264 (53.9)       |                    |
| **Job situation**              |                        |                 |                  |                    |
| Employed/Paid Internship       | 602 (84.6)             | 188 (84.7)      | 414 (84.5)       |                    |
| Unemployed                     | 64 (9.0)               | 29 (13.1)       | 35 (7.1)         | 0.001*             |
| Other                          | 46 (6.4)               | 5 (2.3)         | 41 (8.4)         |                    |
| **Income perception**          |                        |                 |                  |                    |
| Live comfortable               | 83 (11.6)              | 24 (10.8)       | 59 (12.0)        | 0.883              |
| Can live                       | 442 (62.0)             | 140 (62.8)      | 302 (61.6)       |                    |
| Live with difficulties         | 188 (26.4)             | 59 (26.5)       | 129 (26.3)       |                    |
| **Household Members (number)** |                        |                 |                  |                    |
| ≤3                             | 352 (49.5)             | 105 (47.5)      | 247 (50.4)       | 0.769              |
| 4                              | 283 (39.8)             | 91 (41.2)       | 192 (39.2)       |                    |
| >4                             | 76 (10.7)              | 25 (11.3)       | 51 (10.4)        |                    |
| **Household classification**   |                        |                 |                  |                    |
| Mother or father with children | 60 (8.4)               | 20 (9.0)        | 40 (8.2)         | 0.811              |
| Couple with children           | 589 (82.6)             | 185 (83.0)      | 404 (82.4)       |                    |
| Couple with children and other | 64 (9.0)               | 18 (8.1)        | 46 (9.4)         |                    |
| **Household number of children** |                        |                 |                  |                    |
| 1                              | 356 (52.6)             | 95 (46.6)       | 270 (55.1)       | 0.100              |
| 2                              | 286 (41.2)             | 93 (45.6)       | 193 (39.4)       |                    |
| ≥3                             | 43 (6.2)               | 16 (7.8)        | 27 (5.5)         |                    |
| **Sex of participant child**   |                        |                 |                  |                    |
| Female                         | 342 (47.9)             | 107 (47.8)      | 225 (45.0)       | 0.962              |
| Male                           | 372 (52.1)             | 117 (52.2)      | 255 (55.0)       |                    |
| **Age of participant child**   |                        |                 |                  |                    |
| 2–3 years                      | 322 (45.1)             | 95 (42.4)       | 227 (46.3)       | 0.614              |
| 4 years                        | 224 (31.4)             | 73 (32.6)       | 151 (30.8)       |                    |
| 5–6 years                      | 168 (23.5)             | 56 (25.0)       | 112 (22.9)       |                    |
| **Food Insecurity level**      |                        |                 |                  |                    |
| Food security                  | 517 (77.5)             | 184 (85.2)      | 333 (73.8)       | 0.001*             |
| Food insecurity                | 150 (22.5)             | 32 (14.8)       | 118 (26.2)       |                    |
| **Nutrition knowledge**        |                        |                 |                  |                    |
| ≤ 50% of correct answers       | 104 (15.9)             | 24 (14.6)       | 80 (16.3)        |                    |
| 51–75% of correct answers      | 347 (53.1)             | 90 (54.9)       | 257 (52.4)       | 0.827              |

(Continued)
The authors considered the item “It is healthier to my child to consume less salt” in factor 4 because it was conceptually framed, and its lower loading could be due to projection issues (high proportion of “completely agree”). In addition, internal consistency is similar with or without the item for both factor 4 and factor 1.

Characterization of parents’ food practices, preferences, skills and attitudes on child’s food consumption

Regarding parental practices, preferences, skills and attitudes, no significant differences between participants’ responses (online vs. paper) were found for 18 items (out of 22), and for 4 dimensions (out of 5). Significant differences were observed for 4 items and 1 dimension: “I encourage my child to eat vegetables” (p = 0.043), “I can prepare vegetable meals that my child like” (p = 0.040), “It is important to me to avoid buying food with high amount of sugar” (p = 0.009) and “It is important to me that my child does not consume a lot of salt everyday” (p = 0.018), and the dimension: “Parental awareness regarding sugar and salt intake” (p = 0.034), with higher mean scores observed for participants who answered the questionnaire on paper (Table 2). Parents’ practices, preferences, skills and attitudes on child’s food consumption were evaluated considering socio-demographic characteristics and nutrition knowledge of participants (Table 3).

Mothers revealed a significantly more positive perception of F&V’s satiety ability than fathers and less appetite for salt and sweet beverages (p<0.001).

Parents aged 30 or more years old, revealed to have significantly more influence on child’s behaviors modulation and active promoting of F&V consumption than younger parents (p<0.001). Also, considering skills for choosing/preparing healthy food and awareness regarding sugar and salt intake, older fathers or mothers had significantly higher skills (p<0.001) and higher concerns regarding salt and sugar intake (p<0.001) than younger ones.

Parents from the higher education groups had a significantly more positive perception of F&V’s satiety ability, and less appetite for salt and sweet beverages than their peers from lower education groups (p<0.001). Parental awareness regarding sugar and salt intake was also significantly higher in the group with more than 12 schooling years compared to lower education groups (p = 0.047).

Regarding parental income perception, parental modelling and active promotion of F&V consumption were significantly lower in families who reported to live with difficulties comparing to families who live without constraints (p = 0.016).
## Table 2. Factors’ characterization, reliability and factorial loadings by Varimax rotation (5 factors extracted) (N = 618).

| Factor/item                                                                 | Paper (n = 205) | Online (n = 413) | Total participants (n = 618) | Completely agreement | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|------------------------------------------------------------------------------|-----------------|------------------|-------------------------------|----------------------|----------|----------|----------|----------|----------|
| Mean (SD)                                                                    | Mean (SD)       | P-value          | Mean (SD)                    | n (%)                |          |          |          |          |          |
| **1. Parental modelling and active promotion of child’s F&V consumption**    |                 |                  |                               |                      |          |          |          |          |          |
| (explained variance: 21.6%; \( \alpha = 0.729 \))                           | 4.70 (0.39)     | 4.62 (0.49)      | 0.179                        | 4.67 (0.44)          | -        |          |          |          |          |
| ▪ We frequently eat vegetables in family                                     | 4.57 (0.71)     | 4.45 (0.80)      | 0.058                        | 4.51 (0.75)          | 390 (63.1) | 0.697    |
| ▪ I encourage my child to eat vegetables                                    | 4.85 (0.37)     | 4.74 (0.61)      | 0.043*                       | 4.79 (0.51)          | 508 (82.2) | 0.674    |
| ▪ We frequently eat fruit in family                                         | 4.49 (0.85)     | 4.46 (0.86)      | 0.593                        | 4.47 (0.84)          | 397 (64.2) | 0.658    |
| ▪ I encourage my child to eat fruit                                         | 4.95 (0.24)     | 4.90 (0.34)      | 0.051                        | 4.93 (0.30)          | 580 (93.9) | 0.605    |
| ▪ I can make my child to eat fruit as dessert                               | 4.66 (0.64)     | 4.55 (0.84)      | 0.025                        | 4.63 (0.73)          | 450 (72.8) | 0.526    |
| **2. Parental skills for choosing/preparing healthy food**                  |                 |                  |                               |                      |          |          |          |          |          |
| (explained variance: 10.1%; \( \alpha = 0.745 \))                           | 4.16 (0.61)     | 4.06 (0.71)      | 0.097                        | 4.10 (0.67)          | -        |          |          |          |          |
| ▪ I can choose products with low salt content                               | 4.13 (0.94)     | 3.98 (1.00)      | 0.056                        | 4.07 (0.95)          | 237 (38.3) | 0.813    |
| ▪ I can choose products with low sugar content                              | 4.32 (0.85)     | 4.16 (0.96)      | 0.061                        | 4.24 (0.89)          | 291 (47.1) | 0.748    |
| ▪ I can prepare a pleasure meal without salt                                | 3.53 (1.21)     | 3.50 (1.23)      | 0.731                        | 3.52 (1.21)          | 141 (22.8) | 0.610    |
| ▪ I can prepare vegetable meals that my child like                          | 4.43 (0.80)     | 4.25 (0.95)      | 0.040*                       | 4.33 (0.88)          | 332 (53.7) | 0.478    |
| ▪ I can prepare meals with 1/3 of the dish with vegetables                  | 4.38 (0.78)     | 4.27 (0.86)      | 0.145                        | 4.33 (0.81)          | 309 (50.0) | 0.419    |
| **3. Parental food preferences and satiety perception**                     |                 |                  |                               |                      |          |          |          |          |          |
| (explained variance: 8.1%; \( \alpha = 0.702 \))                           | 3.35 (0.92)     | 3.33 (0.99)      | 0.819                        | 3.35 (0.97)          | -        |          |          |          |          |
| ▪ Vegetables do not satiate me R²                                             | 3.77 (1.32)     | 3.65 (1.35)      | 0.216                        | 3.72 (1.33)          | 33 (5.3)  | 0.878    |
| ▪ Fruit does not satiate me R                                                | 3.66 (1.31)     | 3.62 (1.32)      | 0.732                        | 3.66 (1.31)          | 31 (5.0)  | 0.862    |
| ▪ Food without salt has no taste R                                            | 3.03 (1.27)     | 3.04 (1.35)      | 0.885                        | 3.06 (1.33)          | 63 (10.2) | 0.608    |
| ▪ I like the sweet beverages taste R                                         | 2.95 (1.25)     | 2.92 (1.38)      | 0.688                        | 2.95 (1.34)          | 74 (12.0) | 0.512    |
| **4. Parental awareness regarding sugar and salt intake**                   |                 |                  |                               |                      |          |          |          |          |          |
| (explained variance: 7.2%; \( \alpha = 0.613 \))                           | 4.78 (0.37)     | 4.68 (0.47)      | 0.034*                       | 4.72 (0.44)          | -        |          |          |          |          |
| ▪ It is healthier to my child to consume less salt                           | 4.90 (0.38)     | 4.81 (0.61)      | 0.064                        | 4.85 (0.52)          | 554 (89.6) | 0.418    |
| ▪ It is important to me to avoid have sugary products easily available for my child | 4.62 (0.69)     | 4.61 (0.73)      | 0.817                        | 4.64 (0.70)          | 451 (73.0) | 0.675    |
| ▪ It is important to me to avoid buying food with high amount of sugar      | 4.72 (0.65)     | 4.59 (0.75)      | 0.009*                       | 4.65 (0.71)          | 460 (74.7) | 0.674    |
| ▪ It is important that my child does not drink a high amount of sweet beverages | 4.86 (0.55)     | 4.75 (0.75)      | 0.051                        | 4.79 (0.69)          | 543 (87.9) | 0.658    |
| ▪ It is important to me that my child does not consume a lot of salt everyday | 4.79 (0.59)     | 4.60 (0.93)      | 0.018*                       | 4.66 (0.85)          | 500 (80.9) | 0.580    |
| **5. Parental allowance regarding child’s F&V consumption**                 |                 |                  |                               |                      |          |          |          |          |          |
| (explained variance: 5.4%; \( \alpha = 0.552 \))                           | 4.53 (0.65)     | 4.50 (0.67)      | 0.839                        | 4.52 (0.66)          | -        |          |          |          |          |
| ▪ At home, my child can eat all the vegetables that he/she likes             | 4.56 (0.75)     | 4.51 (0.84)      | 0.708                        | 4.55 (0.79)          | 417 (67.5) | 0.763    |
| ▪ At home, my child can eat all the fruit that he/she likes                  | 4.50 (0.77)     | 4.49 (0.80)      | 0.997                        | 4.48 (0.80)          | 378 (61.2) | 0.699    |

(Continued)
It was observed that families with a participant female child, had significantly higher skills for choosing/preparing healthy food (p = 0.013) and higher concerns regarding sugar and salt intake comparing with families with a participant male child (p = 0.027).

Parents who revealed lower nutrition knowledge (≤ 50% of correct answers), showed to have fewer practices at home related to positive parental modelling and active promotion of F&V consumption (p = 0.041) and minor concerns regarding child’s sugar and salt intake (p = 0.038), comparing with parents who revealed higher nutrition knowledge at baseline (>75% of correct answers). A significantly better perception of F&V’s satiety ability and lower appetite for salt and sweet beverages was observed for parents with higher baseline nutrition knowledge (p < 0.001).

For parental allowance regarding F&V consumption and frozen vegetables, significant differences were not identified according to socio-demographic characteristics. In general, the lowest mean score was obtained for the parental perception of F&V satiety and preference for salt/sugar flavor. It was observed that a high percentage of parents considered that food without salt has no taste and revealed to like sweet beverages taste.

**Discussion**

**Parents’ practices, preferences, skills and attitudes on child’s food consumption assessment: Instrument proprieties**

In the present study, we tested a questionnaire developed to assess parental practices, preferences, skills and attitudes regarding food consumption. Five dimensions were identified, and one item was excluded (a total of 21 items). Internal reliability of all factors was acceptable (calculated through Cronbach’s alpha), showing satisfying properties. Some dimensions showed low levels of internal reliability possible due to the reduced number of items.

This study shows that the holistic, multidimensional scale studied, easily administrated, may have a high potential for the study of parents’ practices, preferences, skills and attitudes. However, the analytic ability of scale may be improved.

Our results showed that dimensions could interact in a predictable or non-predictable way, reflecting the complexity of parental influences on child’s food consumption. Frozen vegetables were understood by parents as a specific construct apart from fresh vegetables, which may be related to the perceived lower nutritional value of frozen vegetables, comparing to fresh vegetables. This item was not included neither in parental skills for choosing/preparing healthy food nor in parental modelling and active promotion of child’s F&V consumption, as

---

Table 2. (Continued)

| Factor/item | Paper (n = 205) | Online (n = 413) | Total participants (n = 618) | Completely agreement | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|-------------|----------------|----------------|-----------------------------|----------------------|----------|----------|----------|----------|----------|
| Mean (SD²)  | Mean (SD²)  | P-value⁴ | Mean (SD²)  | n (%)  |
| 6. I can prepare meals with frozen vegetables | 4.20 (1.08) | 4.26 (1.01) | 0.662 | 4.28 (0.99) | - | - | - | - | - | - |

1 Factors’ internal reliability calculated for individuals that answered all items of each factor.
2 Items marked with an R were reverse coded.
3 SD–standard deviation.
4 P-value according to Mann-Whitney test, with 95% of confidence.
5 statistically significant (p<0.05).

https://doi.org/10.1371/journal.pone.0251620.t002
Table 3. Factors’ characterization according to socio-demographic characteristics and nutrition knowledge.

| Respondent | Parental modelling and active promotion of child’s F&V consumption | Parental skills for choosing/preparing healthy food | Parental food preferences and satiety perception | Parental awareness regarding sugar and salt intake | Parental allowance regarding child’s F&V consumption | Frozen vegetables cooking skills |
|------------|---------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|----------------------------------|
|            | Mean (SD)                                                    | Mean (SD)                                    | Mean (SD)                                    | Mean (SD)                                    | Mean (SD)                                    | Mean (SD)                        |
| **Respondent** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| **Mother** | 4.67 (0.44)                                                  | 4.11 (0.65)                                  | 3.41 (0.96)                                  | 4.72 (0.44)                                  | 4.53 (0.65)                                  | 4.28 (1.02)                      |
| **Father** | 4.63 (0.43)                                                  | 4.04 (0.73)                                  | 3.05 (0.94)                                  | 4.71 (0.45)                                  | 4.45 (0.73)                                  | 4.32 (0.79)                      |
| **p**      | 0.082                                                        | 0.492                                        | <0.001*                                      | 0.520                                        | 0.369                                        | 0.624                            |
| **Respondent age (years)** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| <30        | 4.41 (0.62)                                                   | 3.89 (0.63)                                  | 3.29 (0.89)                                  | 4.55 (0.51)                                  | 4.45 (0.65)                                  | 4.06 (1.13)                      |
| 30–40      | 4.68 (0.42)                                                   | 4.08 (0.67)                                  | 3.36 (0.97)                                  | 4.71 (0.44)                                  | 4.53 (0.66)                                  | 4.29 (0.98)                      |
| >40        | 4.75 (0.34)                                                   | 4.26 (0.63)                                  | 3.35 (1.01)                                  | 4.82 (0.38)                                  | 4.50 (0.68)                                  | 4.36 (0.91)                      |
| **p**      | <0.001*                                                      | <0.001*                                      | 0.732                                        | <0.001*                                      | 0.586                                        | 0.196                            |
| **Education level (schooling years)** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| <10        | 4.68 (0.37)                                                   | 4.20 (0.64)                                  | 2.84 (1.06)                                  | 4.66 (0.50)                                  | 4.60 (0.57)                                  | 4.36 (1.02)                      |
| 10–12      | 4.60 (0.51)                                                   | 4.04 (0.71)                                  | 3.27 (0.98)                                  | 4.66 (0.51)                                  | 4.47 (0.68)                                  | 4.25 (1.06)                      |
| >12        | 4.70 (0.40)                                                   | 4.11 (0.64)                                  | 3.51 (0.89)                                  | 4.76 (0.38)                                  | 4.52 (0.67)                                  | 4.29 (0.94)                      |
| **p**      | 0.129                                                        | 0.244                                        | <0.001*                                      | 0.047*                                       | 0.323                                        | 0.561                            |
| **Job situation** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| Employed/Paid Internship | 4.67 (0.43)                                                   | 4.07 (0.67)                                  | 3.36 (0.95)                                  | 4.72 (0.44)                                  | 4.52 (0.67)                                  | 4.27 (0.98)                      |
| Unemployed | 4.61 (0.50)                                                   | 4.23 (0.66)                                  | 3.35 (1.06)                                  | 4.76 (0.40)                                  | 4.52 (0.63)                                  | 4.37 (0.96)                      |
| Other      | 4.71 (0.43)                                                   | 4.24 (0.65)                                  | 3.22 (1.10)                                  | 4.57 (0.58)                                  | 4.56 (0.46)                                  | 4.35 (1.13)                      |
| **p**      | 0.456                                                        | 0.075                                        | 0.817                                        | 0.294                                        | 0.885                                        | 0.449                            |
| **Income perception** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| Live with difficulties | 4.60 (0.46)                                                   | 4.03 (0.72)                                  | 3.34 (1.00)                                  | 4.68 (0.49)                                  | 4.53 (0.63)                                  | 4.34 (0.97)                      |
| Can live   | 4.68 (0.43)                                                   | 4.12 (0.65)                                  | 3.32 (0.97)                                  | 4.72 (0.42)                                  | 4.53 (0.64)                                  | 4.26 (1.00)                      |
| Live comfortable | 4.74 (0.41)                                                   | 4.12 (0.61)                                  | 3.51 (0.84)                                  | 4.77 (0.43)                                  | 4.41 (0.80)                                  | 4.25 (0.97)                      |
| **p**      | 0.016*                                                       | 0.540                                        | 0.304                                        | 0.346                                        | 0.747                                        | 0.575                            |
| **Household Members (number)** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| ≤3         | 4.65 (0.44)                                                   | 4.08 (0.68)                                  | 3.42 (0.98)                                  | 4.70 (0.45)                                  | 4.54 (0.65)                                  | 4.23 (1.03)                      |
| 4          | 4.67 (0.44)                                                   | 4.11 (0.64)                                  | 3.32 (0.98)                                  | 4.71 (0.46)                                  | 4.50 (0.68)                                  | 4.33 (0.95)                      |
| >4         | 4.72 (0.45)                                                   | 4.16 (0.68)                                  | 3.32 (0.83)                                  | 4.82 (0.33)                                  | 4.45 (0.62)                                  | 4.39 (0.91)                      |
| **p**      | 0.085                                                        | 0.571                                        | 0.128                                        | 0.191                                        | 0.301                                        | 0.445                            |
| **Household classification** |                                                                 |                                              |                                              |                                              |                                              |                                  |
| Mother or father with children | 4.71 (0.45)                                                   | 4.21 (0.63)                                  | 3.35 (1.05)                                  | 4.67 (0.49)                                  | 4.57 (0.60)                                  | 4.26 (1.13)                      |
| Couple with children | 4.66 (0.43)                                                   | 4.08 (0.68)                                  | 3.34 (0.97)                                  | 4.72 (0.44)                                  | 4.52 (0.66)                                  | 4.30 (0.96)                      |
| Couple with children and other | 4.65 (0.49)                                                   | 4.14 (0.60)                                  | 3.41 (0.86)                                  | 4.76 (0.41)                                  | 4.41 (0.69)                                  | 4.20 (1.09)                      |
| **p**      | 0.687                                                        | 0.381                                        | 0.991                                        | 0.642                                        | 0.365                                        | 0.885                            |

(Continued)
expected, revealing to be a dimension itself. These results are in line with other studies which showed that individuals have an implicit negative association with frozen vegetables, comparing to fresh vegetables [44] and that consumers associates a higher level of freshness of F&V with minimal product transformation, among other characteristics [45]. Considering this specific theme as a dimension itself, an improvement of this dimension might be explored,

| Table 3. (Continued) |
|----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                      | Parental modelling and active promotion of child’s F&V consumption | Parental skills for choosing/preparing healthy food | Parental food preferences and satiety perception | Parental awareness regarding sugar and salt intake | Parental allowance regarding child’s F&V consumption | Frozen vegetables cooking skills |
|                      | Mean (SD)          | Mean (SD)          | Mean (SD)          | Mean (SD)          | Mean (SD)          | Mean (SD)          |
| Household number of children³ |                      |                      |                      |                      |                      |                      |
| 1                     | 4.65 (0.46)        | 4.09 (0.67)        | 3.41 (0.98)        | 4.71 (0.44)        | 4.53 (0.66)        | 4.24 (1.02)        |
| 2                     | 4.68 (0.41)        | 4.12 (0.64)        | 3.31 (0.94)        | 4.73 (0.45)        | 4.50 (0.66)        | 4.38 (0.91)        |
| ≥3                    | 4.69 (0.50)        | 4.06 (0.82)        | 3.05 (0.97)        | 4.71 (0.45)        | 4.56 (0.47)        | 4.25 (1.02)        |
| p ²                   | 0.213              | 0.887              | 0.084              | 0.674             | 0.654             | 0.277             |
| Sex of participant child |                      |                      |                      |                      |                      |                      |
| Female                | 4.70 (0.42)        | 4.16 (0.66)        | 3.40 (0.97)        | 4.74 (0.45)        | 4.53 (0.65)        | 4.30 (0.95)        |
| Male                  | 4.64 (0.45)        | 4.04 (0.67)        | 3.30 (0.96)        | 4.69 (0.44)        | 4.50 (0.67)        | 4.27 (1.02)        |
| p¹                   | 0.178              | 0.013*             | 0.180              | 0.027*            | 0.668             | 0.910             |
| Age of participant child (years) |                      |                      |                      |                      |                      |                      |
| 2–3                   | 4.66 (0.46)        | 4.09 (0.67)        | 3.33 (0.94)        | 4.70 (0.45)        | 4.57 (0.58)        | 4.30 (0.97)        |
| 4                     | 4.65 (0.42)        | 4.09 (0.66)        | 3.36 (0.96)        | 4.73 (0.47)        | 4.42 (0.72)        | 4.25 (0.98)        |
| 5–6                   | 4.70 (0.43)        | 4.12 (0.67)        | 3.37 (1.02)        | 4.73 (0.41)        | 4.55 (0.70)        | 4.29 (1.01)        |
| p²                   | 0.280              | 0.890              | 0.859              | 0.282             | 0.061             | 0.797             |
| Food Insecurity level ³ |                      |                      |                      |                      |                      |                      |
| Food security         | 4.68 (0.44)        | 4.09 (0.68)        | 3.34 (0.94)        | 4.75 (0.39)        | 4.53 (0.64)        | 4.29 (0.98)        |
| Food insecurity       | 4.66 (0.42)        | 4.14 (0.63)        | 3.41 (1.05)        | 4.74 (0.39)        | 4.52 (0.73)        | 4.30 (1.02)        |
| p¹                   | 0.410              | 0.642              | 0.312              | 0.636             | 0.414             | 0.616             |
| Nutrition knowledge ⁵ |                      |                      |                      |                      |                      |                      |
| ≤ 50% of correct answers     | 4.60 (0.48)        | 4.16 (0.70)        | 3.04 (1.02)        | 4.57 (0.57)        | 4.46 (0.67)        | 4.35 (0.90)        |
| 51–75% of correct answers   | 4.64 (0.47)        | 4.05 (0.70)        | 3.36 (0.97)        | 4.72 (0.43)        | 4.50 (0.69)        | 4.28 (0.98)        |
| >75% total of correct answers | 4.72 (0.39)        | 4.15 (0.61)        | 3.55 (0.90)        | 4.76 (0.42)        | 4.55 (0.63)        | 4.33 (0.98)        |
| p²                   | 0.041*             | 0.377              | <0.001*            | 0.038*            | 0.656             | 0.739             |

¹ p value calculated according with Mann-Whitney test, with 95% of confidence.
² p value calculated according with Kruskal-Wallis test, with 95% of confidence.
³ Sample size were lower due to missing values in the following variables: Respondent age (n = 617), job situation (n = 617), income perception (n = 617), household members (n = 616), household classification (n = 617), household number of children (n = 599), food insecurity (n = 583), nutrition knowledge (n = 564).
⁴ Other: Student, retired, disable, military/community work, domestic, other inactivity situation.
⁵ SD–standard deviation.
⁶ a,b,c homogeneous subsets according to Mann-Whitney test, with 95% of confidence.
⁷ statistically significant (p<0.05).

https://doi.org/10.1371/journal.pone.0251620.t003
namely through a more complex and complete evaluation, including parental perception of frozen vegetables quality and healthiness.

Some differences were observed when comparing dimensions predicted apriori, with final dimensions proposed by the model. According to EPHE [46], items related to energy balance-related behaviors ("We frequently eat vegetables in family" / "We frequently eat fruit in family") were considered in a different dimension than items evaluating active promoting ("I encourage my child to eat vegetables" /"I encourage my child to eat fruit"), which were grouped in the same dimension in our study. Our results confirm that parental allowance and active promotion have distinguished behavioral basis and different levels of parental permissiveness and involvement [47, 48]. To allow a more complete evaluation of parental allowance about child’s eating habits, we consider it should be also evaluated the parental permissiveness to their child to eat energy-dense foods, with high amounts of sugar and salt. This questionnaire shows satisfying properties to investigate several parental practices, preferences, skills and attitudes on child’s food consumption, of F&V, sugar and salt intake.

**Characterization of parents’ food practices, preferences, skills and attitudes on child’s food consumption**

In the present study, it was observed that mothers, older parents, higher educated, those who reported living with no difficulties regarding household income, parents of female children and with higher nutrition knowledge revealed to have significantly higher scores for different dimensions assessed.

Specifically, fathers showed considerable worst ability to identify satiety of F&V, and higher appetite for sugar beverages and salt’s flavor than mothers. These results are consistent with previous findings reported in the literature, which showed that women demonstrated healthier habits [32] and mothers were more likely to be in a healthy weight than fathers [49]. According to a national survey, the average sodium intake was excessive and higher in men compared to women [4] which are in line with our findings.

On the other hand, it would also be expected to observe higher monitoring and concern for children’s eating habits among mothers [50–52], along with higher awareness of the importance of healthy eating [32]. However, in our study, differences between mothers and fathers in those dimensions were not statistically significant.

With increasing age, it was observed an increased parental promotion of child’s F&V consumption through active encouragement and modelling, along with higher awareness regarding sugar and salt intake. These findings are consistent with other studies where healthy eating habits and more concerns about health increases with age [53–55]. Younger parents demonstrated the worst practices and concern about their child’s eating habits which suggests that this group may benefit from an intervention to improve their children’s eating habits.

Another important socio-demographic variable associated with parental practices described in literature, is education [56–58]. In this work, parents less educated revealed to have higher preference for sugar/salt and less perception of F&V satiety ability and lower awareness level regarding child’s sugar and salt intake. These findings are in line with studies showing that education level is associated with better health habits, namely, higher F&V consumption [6]. Other authors reported the impact of higher educated parents in child’s fruit consumption [55] and less sugar-sweetened beverages intake [59]. Parental education is an important determinant of their eating habits, which in turn, influences what children eat [60]. Higher awareness is also consistent with other studies showing that education level is inversely associated with the use of food as rewards [61, 62]. Our results suggest that interventions promoting healthier eating habits are needed and must specially address less educated parents, who may
benefit of a better understanding of sugar and salt’s consequences on health and to be aware of the feasibility of preparing tasty food with no salt addiction.

Along with education level, income has also been recognized as one of the most important determinants of eating habits and health [55]. In our study, parents who reported to live with difficulties demonstrated to have worst practices regarding F&V consumption and be less effective in managing child’s F&V intake comparing with families from higher income. This relation gains relevance considering parent role modeling [60], and it is known that families from low socioeconomic status have worse habits, both adults and children [55]. Considering that most children do not like F&V taste [63] and do not meet its recommendations [64], parental involvement is necessary. Previous results highlighted the need for understanding possible constraints of families related to socioeconomic status and interventions should try to overcome them for positive results.

Differences were found in parental skills for cooking and product selection and awareness regarding sugar/salt intake, according to children’s sex. Parents demonstrated higher scores for these dimensions with their daughters, comparing with parents with a male child. This association was consistent with other studies revealing that parents use different parenting styles for their sons and daughters [65]. It has been reported that children’s sex influences parents’ concerns about weight [66]. M. Campbell, J. Williams [67] demonstrated that mothers were more concerned about weight/health issues of their daughters than with their sons. Despite that, boys are more likely to consume energy-dense foods [4, 68] which may indicate their need for higher monitoring than girls.

Furthermore, it is known that nutrition knowledge is directly associated with eating habits [25, 69]. Parents with higher nutrition knowledge showed higher scores for parental modelling and active promotion of F&V consumption. Our findings are consistent with previous studies that demonstrated an association between nutrition knowledge and eating habits [70, 71]. According to Tabbakh and Freeland-Graves [72], higher maternal nutrition knowledge was found to be related with higher fruit consumption of their child and better quality of overall diet. Similar results were also found with regard to awareness for sugar and salt intake. More knowledge was found to be a good indicator of higher awareness for salt disadvantages [73] and healthier behavior adoption seems to depend of profound knowledge of the health issue. Better food preferences were also found in parents with higher nutrition knowledge, and once more, this association is consistent with previous findings. Nutrition education revealed to predict and increase F&V consumption in overweight adults [69], and increasing knowledge about sugar, was associated with a reduction in sugary food and beverages consumption [74]. Also, in children, F&V consumption was higher in individuals with higher nutrition knowledge [75].

**Limitations and future recommendations**

Interpretation of these results must consider study limitations. A convenience sample was used in this study. Respondents were mostly mothers, employed, highly educated, in a food security situation, and most individuals revealed to be conscientious about all dimensions and to have reasonable nutrition knowledge. Thus, the socio-demographic characteristics of our sample are different comparing to general population. However, this study had a wide geographical distribution, which may overcome the use of a convenience sample. Another limitation is the use of two distinguished methods of data collection, which resulted in some minor but statistically significant differences between participants who respond the questionnaire online or on paper. Nevertheless, these differences could be related to the small sample size. Higher scores for participants who answered the paper version of the questionnaire could be
due to differences in individuals’ profiles or dependent of the format itself. Different tools needed for completing the questionnaire on paper (pen) or online (computer, internet) could influence the surrounding environment in which the questionnaire was fulfilled, and the time spent for completing the questionnaire, which may in turn, conditioning participants’ answers.

The instrument developed and tested under this study showed satisfying characteristics that allow us to investigate parental influences (practices, preferences, skills and attitudes) on child’s food consumption regarding F&V, sugar and salt intake. This instrument reveals to have the advantage of being short and easily delivered, allowing at the same time a comprehensive evaluation on a broad range of parental influences. Future studies using this reliable instrument, focusing on the evaluation of parental habits and influences on child’s intake of F&V, sugar and salt, should be performed in representative samples, including both individuals from high and low socioeconomic status and educational levels. Studies may benefit from a deeper evaluation of parents’ perception of frozen vegetables and allowance practices regarding sugar and salt intake. For more reliable information, an adequate method of data collection should be defined a priori based on the resources and socio-demographic characteristics of the population, which were emphasized to be important.

Supporting information
S1 File.
(RAR)
S2 File.
(DOCX)
S3 File.
(DOCX)

Acknowledgments
We thank the Nutriscience team, the participant families for their cooperation and support.

Author Contributions
Conceptualization: Carla Almeida, José Azevedo, Maria João Gregório, Renata Barros, Patrícia Padrão.

Data curation: Milton Severo.

Formal analysis: Carla Almeida, Milton Severo.

Investigation: Carla Almeida, José Azevedo, Maria João Gregório, Renata Barros, Patrícia Padrão.

Methodology: Carla Almeida, José Azevedo, Maria João Gregório, Renata Barros, Patrícia Padrão.

Project administration: José Azevedo.

Supervision: José Azevedo, Patrícia Padrão.

Writing – original draft: Carla Almeida.

Writing – review & editing: José Azevedo, Patrícia Padrão.
References

1. Global Burden of Disease. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016; 388(10053):1459–544. https://doi.org/10.1016/S0140-6736(16)31012-1 PMID: 27733281

2. Crowe M, O’Sullivan M, Cassetti O, O’Sullivan A. Estimation and consumption pattern of free sugar intake in 3-year-old Irish preschool children. European journal of nutrition. 2020; 59(5):2065–74. https://doi.org/10.1007/s00394-019-02056-8 PMID: 31325041

3. Marinho AR, Severo M, Correia D, Lobato L, Vilela S, Oliveira A, et al. Total, added and free sugar intakes, dietary sources and determinants of consumption in Portugal: the National Food, Nutrition and Physical Activity Survey (IAN-AF 2015–2016). Public Health Nutr. 2020; 23(5):869–81. https://doi.org/10.1017/S1368946519002519 PMID: 31486357

4. University of Porto. Inquérito Alimentar Nacional e de Atividade Física (IAN-AF 2015–2016). 2017.

5. Gonçalves C, Abreu S, Padrão P, Pinho O, Graça P, Breda J, et al. Sodium and potassium urinary excretion and dietary intake: a cross-sectional analysis in adolescents. Food Nutr Res. 2016; 60:29442. https://FoodNutR.2016.60.29442 PMID: 27072344

6. Barends C, Weenen H, Warren J, Hetherington MM, de Graaf C, de Vries JHM. A systematic review of practices to promote vegetable acceptance in the first three years of life. Appetite. 2019; 137:174–37. https://doi.org/10.1016/j.appet.2019.02.003 PMID: 30794819

7. Birch LL. Development of food acceptance patterns in the first years of life. Proceedings of the Nutrition Society. 1998; 57(4):617–24. https://doi.org/10.1079/pnns19980090 PMID: 10096125

8. Nicklaus S, Remy E. Early Origins of Overeating: Tracking Between Early Food Habits and Later Eating Patterns. Current Obesity Reports. 2013; 2(2):179–84.

9. De Bourdeaudhuij I, Klepp KI, Due P, Rodrigo CP, de Almeida M, Wind M, et al. Reliability and validity of a questionnaire to measure personal, social and environmental correlates of fruit and vegetable intake in 10-11-year-old children in five European countries. Public Health Nutr. 2005; 8(2):189–200. https://doi.org/10.1079/phn2004673 PMID: 15877912

10. van Stralen MM, te Velde SJ, Singh AS, De Bourdeaudhuij I, Martens MK, van der Sluis M, et al. EuropeanEnergy balance Research to prevent excessive weight Gain among Youth (ENERGY) project: Design and methodology of the ENERGY cross-sectional survey. BMC Public Health. 2011; 11:65. https://doi.org/10.1186/1471-2458-11-65 PMID: 21281466

11. Fischer C, Brug J, Tak NI, Yngve A, te Velde SJ. Differences in fruit and vegetable intake and their determinants among 11-year-old schoolchildren between 2003 and 2009. The international journal of behavioral nutrition and physical activity. 2011; 8:141. https://doi.org/10.1186/1479-5868-8-141 PMID: 22192661

12. Bere E, Klepp KI. Correlates of fruit and vegetable intake among Norwegian schoolchildren: parental and self-reports. Public Health Nutr. 2004; 7(8):991–8. https://doi.org/10.1079/phn2004619 PMID: 15548337

13. Cooke LJ, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M, Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. Public Health Nutr. 2004; 7 (2):295–302. https://doi.org/10.1079/Phn2003527 PMID: 15003137

14. Reinaerts E, de Nooijer J, Candel M, de Vries N. Explaining school children’s fruit and vegetable consumption: the contributions of availability, accessibility, exposure, parental consumption and habit in addition to psychosocial factors. Appetite. 2007; 48(2):248–58. https://doi.org/10.1016/j.appet.2006.09.007 PMID: 17109996

15. Wardle J, Carnell S, Cooke L. Parental control over feeding and children’s fruit and vegetable intake: how are they related? J Am Diet Assoc. 2005; 105(2):227–32. https://doi.org/10.1016/j.jada.2004.11.006 PMID: 15668680

16. Van Lippevelde W, te Velde SJ, Verloigne M, De Bourdeaudhuij I, Manios Y, Bere E, et al. Associations between home- and family-related factors and fruit juice and soft drink intake among 10- to 12-year-old children. The ENERGY project. Appetite. 2013; 61(1):59–65. https://doi.org/10.1016/j.appet.2012.10.019 PMID: 23154218

17. Hart CN, Raynor HA, Jelalian E, Drotar D. The association of maternal food intake and infants’ and toddlers’ food intake. Child: care, health and development. 2010; 36(3):396–403. https://doi.org/10.1111/j.1365-2214.2010.01072.x PMID: 20337642

18. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6–12-year-old children and effective interventions to increase consumption. Journal of Human Nutrition and Dietetics. 2005; 18 (6):431–43. https://doi.org/10.1111/j.1365-277X.2005.00648.x PMID: 16351702

19. Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Increasing children’s acceptance of vegetables; a randomized trial of parent-led exposure. Appetite. 2003; 40(2):155–62. https://doi.org/10.1016/s0195-6663(02)00135-6 PMID: 12781165
20. Rosenkranz RR, Dzewaltowski DA. Model of the home food environment pertaining to childhood obesity. Nutr Rev. 2008; 66(3):123–40. https://doi.org/10.1111/j.1753-4887.2008.00017.x PMID: 18289177

21. Cutler GJ, Flood A, Hanan P, Neumark-Sztainer D. Multiple sociodemographic and socioenvironmental characteristics are correlated with major patterns of dietary intake in adolescents. J Am Diet Assoc. 2011; 111(2):230–40. https://doi.org/10.1016/j.jada.2010.05.052 PMID: 21272697

22. Seaman KL, Gorlick MA, Vekaria KM, Hsu M, Zald DH, Samanez-Larkin GR. Adult age differences in decision making across domains: Increased discounting of social and health-related rewards. Psychol Aging. 2016; 31(7):737–46. https://doi.org/10.1037/pag0000131 PMID: 27831713

23. Furst T, Connors M, Bisogni CA, Sobal J, Falk LW. Food choice: a conceptual model of the process. Appetite. 1996; 26(3):247–65. https://doi.org/10.1016/0002-8223(96)00019-6 PMID: 880481

24. Glanz K, Basil M, Maibach E, Goldberg J, Snyder D. Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. J Am Diet Assoc. 1998; 98(10):1116–26. https://doi.org/10.1016/S0002-8223(98)00260-0 PMID: 9787717

25. Vidgen H, Gallegos D. What is food literacy and does it influence what we eat: a study of Australian food experts 2011.

26. Lyerly JE. Associations between food choice values of parental guardians, socioeconomic status, home food availability, and child dietary intake: Faculty of The University of North Carolina at Charlotte; 2015.

27. Engler-Stringer R. Food, Cooking Skills, and Health: A Literature Review 2010. 141–5 p.

28. Hartmann C, Dohle S, Siegrist M. Importance of cooking skills for balanced food choices. Appetite. 2013; 65:125–31. https://doi.org/10.1016/j.appet.2013.01.016 PMID: 23402717

29. Wrieden WL, Anderson AS, Longbottom PJ, Valentine K, Stead M, Caraher M, et al. The impact of a community-based food skills intervention on cooking confidence, food preparation methods and dietary choices—an exploratory trial. Public Health Nutr. 2007; 10(2):203–11. https://doi.org/10.1017/S1368980007246658 PMID: 17261231

30. Haynes-Maslow L, Parsons SE, Wheeler SB, Leone LA. A qualitative study of perceived barriers to fruit and vegetable consumption among low-income populations. North Carolina, 2011. Prev Chronic Dis. 2013; 10:E34. https://doi.org/10.5888/pcd10.12026 PMID: 23489339

31. Rozin P, Spranca M, Krieger Z, Neuhaus R, Surillo D, Swerdlin A, et al. Preference for natural: instrument and ideational/moral motivations, and the contrast between foods and medicines. Appetite. 2004; 43(2):147–54. https://doi.org/10.1016/j.appet.2004.03.005 PMID: 15455801

32. Jansen E, Harris HA, Mallan KM, Daniels L, Thorpe K. Measurement invariance of the Feeding Practices and Structure Questionnaire-28 among a community of socioeconomically disadvantaged mothers and fathers. Appetite. 2018; 120:115–22. https://doi.org/10.1016/j.appet.2017.08.030 PMID: 28864257

33. Jansen E, Mallan KM, Daniels LA. Extending the validity of the Feeding Practices and Structure Questionnaire. International Journal of Behavioral Nutrition and Physical Activity. 2015; 12(1):90. https://doi.org/10.1186/s12966-015-0253-x PMID: 26123046

34. Jansen E, Mallan KM, Nicholson JM, Daniels LA. The feeding practices and structure questionnaire: construction and initial validation in a sample of Australian first-time mothers and their 2-year olds. International Journal of Behavioral Nutrition and Physical Activity. 2014; 11(1):72.

35. Jansen E, Williams KE, Mallan KM, Nicholson JM, Daniels LA. The Feeding Practices and Structure Questionnaire (FPSQ-28): A parsimonious version validated for longitudinal use from 2 to 5 years. Appetite. 2016; 100:172–80. https://doi.org/10.1016/j.appet.2016.02.031 PMID: 26911263

36. Mushér-Eizenman D, Holub S. Comprehensive Feeding Practices Questionnaire: Validation of a New Measure of Parental Feeding Practices. Journal of Pediatric Psychology. 2007; 32(8):960–72. https://doi.org/10.1093/pepsy/jsm037 PMID: 17535817

37. Warkentin S, Mais LA, Latorre MdRDdO, Carnell S, Taddei JAdAC. Validation of the comprehensive feeding practices questionnaire in parents of preschool children in Brazil. BMC Public Health. 2016; 16(1):603. https://doi.org/10.1186/s12889-016-3282-8 PMID: 27435192

38. McCurdy K, Gorman KS. Measuring family food environments in diverse families with young children. Appetite. 2010; 54(3):615–8. https://doi.org/10.1016/j.appet.2010.03.004 PMID: 20227449

39. Azevedo J, Padrião P, Gregório MJ, Almeida C, Moutinho N, Lien N, et al. A Web-Based Gamification Program to Improve Nutrition Literacy in Families of 3- to 5-Year-Old Children: The Nutriscience Project. Journal of nutrition education and behavior. 2018. https://doi.org/10.1016/j.jneb.2018.10.008 PMID: 30579894

40. Gregório M, Graça P, Nogueira PJ, Gomes S, Santos CA, Boavida J. Proposta metodológica para a avaliação da Insegurança Alimentar em Portugal. Nutrições. 2014; 21:4–11.

41. Gibbs H, Chapman-Novakofski K. Establishing content validity for the Nutrition Literacy Assessment Instrument. Preventing chronic disease. 2013; 10:E109-E. https://doi.org/10.5888/pced10.120267 PMID: 23823698
42. Mantziki K, Vassilopoulos A, Radulian G, Borys J-M, du Plessis H, Gregório MJ, et al. Promoting health equity in European children: Design and methodology of the prospective EPHE (Epode for the Promotion of Health Equity) evaluation study. BMC Public Health. 2014; 14(1):303. https://doi.org/10.1186/1471-2458-14-303 PMID: 24690078

43. van Griethuijsen RALF, van Eijck MW, Haste H, den Brok PJ, Skinner NC, Mansour N, et al. Global Patterns in Students’ Views of Science and Interest in Science. Research in Science Education. 2015; 45(4):581–603.

44. Connell PM, Finkelstein SR, Scott ML, Vallen B. Negative associations of frozen compared with fresh vegetables. Appetite. 2018; 127:299–302. https://doi.org/10.1016/j.appet.2018.05.134 PMID: 29787828

45. Péneau S. Freshness of fruits and vegetables: consumer language and perception. British Food Journal. 2009; 111(3):243–56.

46. Mantziki K, Vassilopoulos A, Radulian G, Borys J-M, Du Plessis H, Gregório MJ, et al. Inequities in energy-balance related behaviours and family environmental determinants in European children: baseline results of the prospective EPHE evaluation study. BMC Public Health. 2015; 15(1):1203. https://doi.org/10.1186/s12889-015-2540-0 PMID: 26630926

47. Hoerr SL, Hughes SO, Fisher JO, Nicklas TA, Liu Y, Shewchuk RM. Associations among parental feeding styles and children’s food intake in families with limited incomes. The international journal of behavioral nutrition and physical activity. 2009; 6:55. https://doi.org/10.1186/1479-5868-6-55 PMID: 19678947

48. Brown M, Roman NV. Nutritional Knowledge, Parenting Styles and Feeding Practices of a South African Sample of Parents. Ecology of Food and Nutrition. 2019:1–19. https://doi.org/10.1080/03670244.2019.1564872 PMID: 31274336

49. Chourdakis M, Tzellos T, Papazisis G, Toulis K, Kouvelas D. Eating habits, health attitudes and obesity indices among medical students in northern Greece. Appetite. 2010; 55(3):722–5. https://doi.org/10.1016/j.appet.2010.08.013 PMID: 20801179

50. Pulley C, Galloway AT, Webb RM, Payne LO. Parental child feeding practices: how do perceptions of mother, father, sibling, and self vary? Appetite. 2014; 80:96–102. https://doi.org/10.1016/j.appet.2014.05.001 PMID: 24819343

51. Adamson M, Blicht EJ. Bringing dads to the table: Comparing mother and father reports of child behaviour and parenting at mealtimes. Journal of Family Studies. 2014; 20(2):118–27.

52. Blissett J, Meyer C, Haycraft E. Maternal and paternal controlling feeding practices with male and female children. Appetite. 2006; 47(2):212–9. https://doi.org/10.1016/j.appet.2006.04.002 PMID: 16735080

53. Verbeke W, Vackier I. Individual determinants of fish consumption: application of the theory of planned behaviour. Appetite. 2005; 44(1):67–82. https://doi.org/10.1016/j.appet.2004.08.006 PMID: 15604034

54. Keski-Rahkonen A, Kaprio J, Rissanen A, Virkkunen M, Rose RJ. Breakfast skipping and health-compromising behaviors in adolescents and adults. European journal of clinical nutrition. 2003; 57(7):842–53. https://doi.org/10.1038/sj.ejcn.1601618 PMID: 12821884

55. Rodenburg G, Oenema A, Kremers SPJ, van de Mheen D. Parental and child fruit consumption in the context of general parenting, parental education and ethnic background. Appetite. 2012; 58(1):364–72. https://doi.org/10.1016/j.appet.2011.11.001 PMID: 22094182

56. Javaheri Tehrani F, Nikpour S, Haji Kazemi EA, Sanaii N, Shariat Panahi SA. The effect of education based on health belief model on health beliefs of women with urinary tract infection. Int J Community Based Nurs Midwifery. 2014; 2(1):2–11. PMID: 25349840

57. Lawrence W, Skinner C, Haslam C, Robinson S, Inskip H, Barker D, et al. Why women of lower educational attainment struggle to make healthier food choices: the importance of psychological and social factors. Psychol Health. 2009; 24(9):1003–20. https://doi.org/10.1080/08870440802460426 PMID: 20205042

58. Gevers DW, Kremer SPJ, de Vries NK, van Assema P. Intake of energy-dense snack foods and drinks among Dutch children aged 7–12 years: how many, how much, when, where and which? Public Health Nutr. 2016; 19(1):83–92. https://doi.org/10.1017/S1368946215000877 PMID: 25850560

59. Gase LN, Robles B, Barragan NC, Kuo T. Relationship Between Nutritional Knowledge and the Amount of Sugar-Sweetened Beverages Consumed in Los Angeles County. Health education & behavior: the journal of health education. 2014; 41(4):431–9. https://doi.org/10.1177/1090198114529128 PMID: 24717193

60. Vaught AE, Martin CL, Ward DS. What matters most—what parents model or what parents eat? Appetite. 2018; 126:102–7. https://doi.org/10.1016/j.appet.2018.03.025 PMID: 29604319

61. Blissett J, Haycraft E. Are parenting style and controlling feeding practices related? Appetite. 2008; 50(2–3):477–85. https://doi.org/10.1016/j.appet.2007.10.003 PMID: 18023502

62. Mushar-Eizenman DR, de Lauzon-Guillain B, Holub SC, Lepore E, Charles MA. Child and parent characteristics related to parental feeding practices. A cross-cultural examination in the US and France. Appetite. 2009; 52(1):89–95. https://doi.org/10.1016/j.appet.2008.08.007 PMID: 18789986
63. Anzman-Frasc S, Ventura AK, Ehrenberg S, Myers KP. Promoting healthy food preferences from the start: a narrative review of food preference learning from the prenatal period through early childhood. Obes Rev. 2018; 19(4):576–604. https://doi.org/10.1111/obr.12658 PMID: 29266778

64. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, et al. Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey. Annals of nutrition & metabolism. 2005; 49(4):236–45.

65. McKinney C, Renk K. Differential Parenting Between Mothers and Fathers: Implications for Late Adolescents. Journal of Family Issues. 2007; 29(6):806–27.

66. Field AE, Camargo CA Jr., Taylor CB, Roberts SB, Colditz GA. Peer, parent, and media influences on the development of weight concerns and frequent dieting among preadolescent and adolescent girls and boys. Pediatrics. 2001; 107(1):54–60. https://doi.org/10.1542/peds.107.1.54 PMID: 11134434

67. Campbell M., Williams J., Hampton A., Wake M.. Maternal concern and perceptions of overweight in Australian preschool-aged children. The Medical Journal of Australia, 184 (6), pp 274–277 2006. https://doi.org/10.5694/j.1326-5377.2006.tb00236.x PMID: 16548831

68. Garriguet D. Beverage consumption of children and teens. Health reports. 2008; 19(4):17–22. PMID: 19226923

69. Wagner MG, Rhee Y, Honrath K, Blodgett Salafia EH, Terbizan D. Nutrition education effective in increasing fruit and vegetable consumption among overweight and obese adults. Appetite. 2016; 100:94–101. https://doi.org/10.1016/j.appet.2016.02.002 PMID: 26850310

70. Pillai KG, Liang Y-S, Thwaites D, Sharma P, Goldsmith R. Regulatory focus, nutrition involvement, and nutrition knowledge. Appetite. 2019; 137:267–73. https://doi.org/10.1016/j.appet.2019.03.008 PMID: 30862455

71. Sahingoz SA, Sanlier N. Compliance with Mediterranean Diet Quality Index (KIDMED) and nutrition knowledge levels in adolescents. A case study from Turkey. Appetite. 2011; 57(1):272–7. https://doi.org/10.1016/j.appet.2011.05.307 PMID: 21624407

72. Tabbakh T, Freeland-Graves JH. The home environment: A mediator of nutrition knowledge and diet quality in adolescents. Appetite. 2016; 105:46–52. https://doi.org/10.1016/j.appet.2016.05.002 PMID: 27170447

73. Grimes CA, Riddell LJ, Nowson CA. Consumer knowledge and attitudes to salt intake and labelled salt information. Appetite. 2009; 53(2):189–94. https://doi.org/10.1016/j.appet.2009.06.007 PMID: 19540891

74. Gupta A, Smithers LG, Harford J, Merlin T, Braunack-Mayer A. Determinants of knowledge and attitudes about sugar and the association of knowledge and attitudes with sugar intake among adults: A systematic review. Appetite. 2018; 126:185–94. https://doi.org/10.1016/j.appet.2018.03.019 PMID: 29634988

75. Lacy KE, Spence AC, McNaughton NA, Crawford DA, Wyse RJ, Wolfenden L, et al. Home environment predictors of vegetable and fruit intakes among Australian children aged 18 months. Appetite. 2019; 139:95–104. https://doi.org/10.1016/j.appet.2019.04.009 PMID: 30991083