



# A narrative review on food neophobia throughout the lifespan: relationships with dietary behaviours and interventions to reduce it

Yasemin Karaağaç\* and Ezgi Bellikci-Koyu

Izmir Katip Çelebi University, Faculty of Health Sciences, Department of Nutrition and Dietetic, Izmir, Turkey

(Submitted 3 November 2021 – Final revision received 8 November 2022 – Accepted 14 November 2022 – First published online 17 November 2022)

## Abstract

Food neophobia is defined as the unwillingness to taste new foods and the avoidance of unfamiliar foods. This eating behaviour is a complex issue, and both genetic and environmental factors play a role in it. The aim of this review is to understand its relationships with dietary behaviours throughout the lifespan and to examine the impact of interventions on food neophobia. A literature search was performed using the PubMed, Web of Science, Cochrane Library and ScienceDirect databases. As a result of the screening, a total of 139 studies, seven of which were intervention studies, were included in this review. According to current evidence, food neophobia is negatively associated with the acceptance of not only novel/unfamiliar foods but also familiar foods. Many studies have shown that food neophobia is negatively associated with the hedonics and consumption of core foods, especially vegetables and fruits. Individuals with higher levels of food neophobia are less familiar with many foods, but familiarity is a prominent motivator in food choices for these individuals. Therefore, it may be considered a barrier limiting diet quality and this trend is similar for both children and adults. However, food neophobia is not an unchangeable personality trait. Intervention studies have pointed out that educational programmes and food-related activities that increase familiarity and exposure to foods and create positive attitudes towards and positive experiences with foods can reduce food neophobia. The results highlight that people with high food neophobia need more support to improve their diets and the quality of dietary behaviour.

**Key words:** Diet quality: Eating behaviour: Food consumption: Food liking: Food neophobia

Humans encounter new situations and stimuli throughout their lives. Positive attitudes of the human organism, such as the attraction to these stimuli or situations, are called 'neophilia', while negative attitudes such as avoidance are called 'neophobia'. Neophobia is the reluctance towards or avoidance of new stimuli and situations because they have not been experienced or recognised before. There are several types of neophobia, including object, food, odour, spatial, social or predator neophobia. Food neophobia is one of the most studied types of neophobia in the literature<sup>(1)</sup>, defined as the avoidance of unfamiliar and novel foods or the hesitance to ingest new foods. It is considered a personal characteristic or behaviour pattern<sup>(2,3)</sup>, and it has also been associated with physiological reactions. Raudenbush and Capiola<sup>(4)</sup> reported that the physiological responses of food neophobics and neophilics to food stimuli were different, although their responses to non-food stimuli were similar. The pulse, respiratory and galvanic skin responses of neophobics were greater than those of neophilics when pictures of food were shown.

From an evolutionary perspective, food neophobia is considered a survival mechanism. As omnivores, humans can consume

and digest many foods. This has provided an advantage for humans in easily adapting to new food environments and surviving for millennia. However, some plants or animals consumed by humans are likely to be toxic or poisonous. For this reason, while humans, like other mammalian omnivores, are often willing and curious in response to novel foods, they may also be fearful and anxious, and this situation is called 'the omnivore's dilemma'<sup>(2)</sup>. Food neophobia provided great advantages for human beings who lived as hunter-gatherers in the past. Today, however, foods are generally safe for consumption; therefore, food neophobia can be a disadvantage by limiting the diversity and quality of the diet<sup>(5–10)</sup>. To our knowledge, no review has focused on the relationship between food neophobia and dietary behaviour. Although a valuable systematic review<sup>(11)</sup> on food neophobia has been published, the relationships between dietary behaviours such as food familiarity, food preferences, food intake, diet variety, diet quality and food neophobia were not examined separately in that review. Therefore, in this narrative review, our objective was to examine the relationship between food neophobia and dietary behaviours throughout the lifespan and to examine the impact of interventions on food neophobia.

**Abbreviations:** FNS, Food Neophobia Scale; FSQ, Food Situations Questionnaire; FV, fruits and vegetables.

\* **Corresponding author:** Yasemin Karaağaç, email [dyt.yaseminozen@gmail.com](mailto:dyt.yaseminozen@gmail.com)



## Methods

### Search strategy

We performed a systematic search with no limitations on time, type of study or language for articles up to June 2022 to identify the relevant published literature. The search was performed using the keywords 'food' AND 'neophobia' in four electronic databases, including PubMed (ALL FIELDS), Web of Science (TOPIC), Cochrane Library (TITLE-ABS-KEY) and Science Direct (TITLE-ABS-KEY). The initial search found 2915 articles in these databases (PubMed: 655, Web of Science: 1598, Cochrane Library: 59 and ScienceDirect: 603). All obtained articles (2915) were exported to reference manager software (EndNote X7) and 1102 entries were eliminated since these articles appeared in multiple databases.

### Study selection

YK and EBK separately reviewed the titles and abstracts of all articles according to the inclusion and exclusion criteria to eliminate irrelevant reports. Studies were included if they met the following criteria: (1) conducted with human participants, (2) evaluated food neophobia using a valid scale and (3) conducted to investigate relationships between food neophobia and dietary behaviours (food familiarity, food hedonics, food preferences, food choice, eating habits, eating behaviours, food intake, nutrient intake, dietary variety, diet quality, etc.) or to examine the effectiveness of interventions on food neophobia. This review included studies evaluating food neophobia with a valid scale before and after interventions.

Studies were excluded if they: (1) were reviews, editorials, conference abstracts, commentaries, letters to the editor, study protocols, case reports, case series, personal or expert opinions or brief/short communications, (2) were designed as qualitative studies, (3) were published in languages other than English, (4) focused on only one food or novel foods like insects, genetically modified foods, cultured meat, clean meat or organic foods, (5) investigated tourist behaviours or (6) evaluated only behavioural food neophobia (willingness to try) without using a valid scale. Additionally, duplicate data were not included in this narrative review. When the abstract was not available or insufficient information was provided there, the full text of the publication was obtained. For each potentially eligible study, two authors read the full-text articles independently according to the inclusion and exclusion criteria. Following that full-text analysis, disagreements between the two authors' decisions were discussed and consensus was reached.

## Results

After removing duplications, the titles and abstracts of 1813 articles were screened. Among them, 1564 articles were excluded because they were irrelevant or their full text could not be accessed. The full texts of the remaining 249 studies were evaluated for eligibility. A total of 110 studies were excluded because sixty-one studies did not address one of the topics explored in this review, thirty-two studies did not evaluate food

neophobia with a valid scale, eleven studies focused on only one food or special foods, two studies were not published in English, two studies were not original research and two studies consisted of duplicate data. Finally, 139 articles were included in the present study.

The studies included in this review used the Food Neophobia Scale (FNS) or modified/adapted versions of the FNS or the Food Situations Questionnaire (FSQ) to assess food neophobia. The FNS, developed by Pliner and Hobden<sup>(2)</sup>, is the most widely used instrument in studies investigating food neophobia. This scale consists of ten items, five of which reflect neophilic characteristics while the other five reflect neophobic characteristics. The FNS is rated using a 7-point scale ranging from 'strongly disagree' (scored as 1 point) to 'strongly agree' (scored as 7 points)<sup>(2)</sup>. The FNS was adapted to different languages and cultures, and some items were removed from the original scale during validation studies. There are also studies that use different versions of the FNS with 5-point response options. The general strategy used to calculate the total FNS score is to create a neophobia score by reversing the scores given to the neophilic items in the scale. Therefore, a higher FNS score indicates that individuals are more neophobic. Although rare, in some exceptional studies, the scores given for neophobic items rather than neophilic items on the scale were reversed and the total FNS score was calculated to create a neophilia score<sup>(12,13)</sup>. However, the categorisation of FNS scores differed significantly between studies. For example, some researchers<sup>(2,14–16)</sup> classified individuals as neophilic or neophobic based on their FNS scores being below or above the mean/median of the study sample, and some<sup>(17)</sup> used half of the maximum FNS score (35 points). Some authors<sup>(6,18,19)</sup> used tertiles, some<sup>(20,21)</sup> used percentiles, some<sup>(8,13,22–26)</sup> used means with standard deviations and some<sup>(7)</sup> used three equal intervals of the FNS score (10–30, 30–50 and 50–70 points) to categorise food neophobia as low, moderate or high. In some studies<sup>(7,9,22,27,28)</sup>, individuals were divided into three groups according to their FNS scores, and then individuals with low food neophobia were called neophilic and those with high food neophobia were called neophobic. The FNS was also revised as the Child FNS to assess children's food neophobia as reported by parents<sup>(29)</sup>. Furthermore, some studies used the Child FNS to determine the food neophobia of children, while several studies<sup>(23,30,31)</sup> used the FNS filled in by parents instead of children.

The FSQ is a self-report measure of food neophobia for children aged 5–12 years<sup>(32)</sup>. It consists of ten items that describe hypothetical situations in which new foods might be encountered. Children should report how they would feel about tasting or eating them using a face scale, from 'big frown' to 'big smile'<sup>(32)</sup>. Lower FSQ scores indicate higher food neophobia. In the study of Mielby *et al.*<sup>(33)</sup>, the FSQ scores were divided into tertiles and the group with the lowest FSQ scores was the neophobic group, while the group with the highest scores was the neophilic group.

As can be seen, the groups represented by the terms 'neophilic' and 'neophobic' differ between studies. Therefore, attention should be paid to these dichotomous terms when interpreting studies.



### *The relationship between food neophobia and dietary behaviour*

*The relationship between food neophobia and food familiarity, food hedonics and food preferences.* Food preferences are an important concept affecting the dietary behaviour of individuals by influencing food choices<sup>(34)</sup>. 'Food preference' means making a choice between food alternatives, with the choice of A rather than B when both are available<sup>(35)</sup>. Familiarity and hedonics are prominent factors that play important roles in food preferences and are often associated with food neophobia. The concept of 'food familiarity' refers to the cognitive ability to apply the knowledge gained through food<sup>(36)</sup>. Food familiarity is not limited only to food tasting experiences. Experience with a food can take several forms. Having visual, contextual or categorical knowledge regarding a food also creates familiarity with that food<sup>(36)</sup>. The other concept of 'food hedonics' expresses the sensory evaluation of food characteristics such as taste, texture and appearance. Food hedonics are often described as the degree of liking or pleasantness.

Food liking and preference are closely related but different concepts. Although individuals may like two different foods equally, they may also prefer one over the other; hence, liking and preference are not necessarily synonymous. However, these are sometimes confused with each other. For example, some studies have used the concept of food preference instead of food liking, although they examined food liking<sup>(37–40)</sup>. Just as preference is a major but not the only driver for food choice, liking is also a significant but not a sole motive of food preference<sup>(34)</sup>. In addition, in some studies<sup>(41,42)</sup>, the situation of liking and eating a food was questioned together and this concept was called preference.

In food neophobia studies, familiarity was usually assessed using 5-point scales from 'I do not recognise the product' to 'I regularly eat it' and willingness to try was usually evaluated by the willingness to try a food ('not at all' to 'extremely willing'). Liking/hedonic ratings have usually been assessed with Likert-type scales by asking the degree of liking foods, from 'dislike extremely' to 'like extremely'. Besides, some studies investigated 'expected liking', which indicates the liking of foods before tasting them, and 'actual liking', which indicates the liking of foods after tasting them. This is important in understanding the relationships between food neophobia, food familiarity, food hedonics and food preferences, as these relationships can influence food choice. Studies investigating the relationships between food neophobia and food familiarity, food hedonics and food preferences in children and adolescents are shown in [Table 1](#), and studies with adults are shown in [Table 2](#).

Familiarity has a notable influence on food preference<sup>(36)</sup>. Children like familiar foods and eat foods they like<sup>(43)</sup>; therefore, it is necessary to increase their familiarity with unfamiliar foods in order to incorporate new foods into their diets and provide dietary diversity<sup>(36)</sup>. However, since a negative attitude towards new foods exists in neophobia<sup>(44–47)</sup>, food neophobia may be considered a barrier to familiarity. Most studies, except two<sup>(48,49)</sup>, supported this by indicating a negative association between food neophobia and familiarity with many food items<sup>(45,50–58)</sup>. Pliner and Hobden<sup>(2)</sup> reported that the negative

relationship between food neophobia and familiarity with foods was limited to unfamiliar foods only.

In general, studies have also indicated that food neophobia negatively affects the 'likelihood of enjoying' and 'willingness to try/taste' familiar foods<sup>(18,45,50,55,59,60)</sup> in addition to novel foods and food products<sup>(2,45–48,54,55,61–65)</sup>. The negative relationship between food neophobia and willingness to try the foods offered was stronger for novel foods than for familiar foods<sup>(45)</sup>. Willingness to try or willingness to cook with specific items such as ethnic foods<sup>(45,51,52,66–68)</sup> or spices<sup>(53,69)</sup> was lower among neophobics. Additionally, young adults who favoured spicy and sour foods and had more tolerance for capsaicin were found to be less neophobic<sup>(70)</sup>. Food neophobia was also negatively associated with the willingness to try/taste new healthy alternative food options such as functional foods<sup>(44,68,71)</sup>. Schickenberg *et al.*<sup>(72)</sup> reported that as food neophobia increased, familiarity with different healthy food alternatives and the willingness to taste them decreased.

Food neophobia was negatively associated with liking many food items, particularly strong-tasting<sup>(39,49)</sup> and unfamiliar/novel foods<sup>(47,48,73,74)</sup> in children and adolescents<sup>(33,37–39,42,50,75–82)</sup> and in adults<sup>(5,18,40,47–49,57,69,73,79,83–85)</sup>. In large-scale research ( $n$  8906) including eight different studies conducted in five countries, food neophobia was inversely associated with the liking of the majority of the 219 considered food and beverage items<sup>(73)</sup>. In another study<sup>(18)</sup>, food neophobia was negatively associated with even the liking of foods and beverages commonly found in the diet. Individuals with higher levels of food neophobia gave lower actual liking<sup>(23,33,74,75)</sup> and pleasantness ratings<sup>(86)</sup> to food after taste assessments and accepted foods less often<sup>(58,87)</sup> than individuals with lower food neophobia. From a broader perspective, food neophobia was negatively associated with food enjoyment<sup>(88)</sup> and a general liking for the act of eating<sup>(5)</sup>.

Among food groups, studies consistently indicate that food neophobia is negatively related to the liking of fruits and/or vegetables in children and adolescents<sup>(39,42,60,71,75,77,78,89)</sup> and also in adults<sup>(5,49,56,57,79,83,84,90,91)</sup>. Laureati *et al.*<sup>(80)</sup> found that food neophobia was inversely correlated with the liking of both vegetables and some fruits among Italian children and reported that children's liking scores for vegetables significantly decreased with increasing levels of food neophobia, but the liking scores for fruits were stable according to the children's levels of food neophobia. For this reason, the authors argued that the best indicator of distinguishing food neophobia in children was their liking of vegetables. In line with that view, in a study conducted in Switzerland, increased food neophobia was associated with a decrease in the liking of vegetables, whole-grain bread, crisps, salty nuts and salty snacks, but it was not found to be associated with the liking of fruits among adults<sup>(79)</sup>. In another study, food neophobia was associated with a higher proportion of vegetables never tried by children, but it was not associated with the proportion of fruits or non-core foods never tried<sup>(71)</sup>. Furthermore, the negative correlation between food neophobia and liking of vegetables was found to be stronger than the correlation between food neophobia and liking of fruits<sup>(37)</sup>. One of the possible explanations for this stronger association between food neophobia and liking vegetables compared with liking fruits is that vegetables are not as sweet as fruits and some



**Table 1.** Studies investigating the relationship between food neophobia and food familiarity, food hedonics and food preferences in children and adolescents

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Appleton <i>et al.</i> <sup>(77)</sup>	736	Adolescents Age: 14.3 ± 1.6 years 51.0 % female 49.0 % male	FNS† (10 items, 7-point scale)	Liking was assessed using a 9-point scale (11 vegetable items differing according to appealing sensory properties)	Liking of vegetables with both more appealing (carrots, peas, sweetcorn and tomatoes) and less appealing (broccoli, cauliflower, green salad and spinach) sensory properties was higher among individuals with lower levels of food neophobia
Donadini <i>et al.</i> <sup>(152)</sup>	60	Children Age: 4–5 years 48.3 % female 51.7 % male	CFNS† (6 items, 4-point scale)	After lunch, meal liking was assessed using a 5-point facial scale	Food neophobia was negatively associated with the liking of meals
Fernandez <i>et al.</i> <sup>(75)</sup>	Baseline: 226 Follow-up: 134	Children Baseline: Age: 70.9 ± 8.5 months 51.8 % female 48.2 % male Follow-up: Age: 101.9 ± 11.2 months 51.5 % female 48.5 % male	CFNS† (10 items, 7-point scale)	Children's hedonic ratings (after actual eating) were assessed using a 5-point facial scale (4 vegetables, familiar and unfamiliar)	CFNS scores were inversely correlated with children's hedonic ratings for both familiar and unfamiliar vegetables at baseline and follow-up
Howard <i>et al.</i> <sup>(71)</sup>	230	Infants Age: 2 years 52 % female 48 % male	CFNS† (6 items, 4-point scale)	Liking was assessed using a 5-point scale; results for vegetables (23 items), fruits (17 items) and non-core foods (18 items) were presented	Food neophobia was associated with the liking of fewer FV; it was not associated with the liking of non-core foods Food neophobia was associated with a higher proportion of vegetables never tried by children; it was not associated with the proportion of fruits or non-core foods never tried by children
Laureati <i>et al.</i> <sup>(80)</sup>	528	Children Age: 6–9 years 49.4 % female 50.6 % male	Italian adaptation of the FNS§ (8 items, 5-point facial scale) ≤ 17: low 18–24: medium ≥ 25: high	Liking was assessed using a 7-point hedonic scale (children received small portions of 4 fruits and 4 vegetables)	Food neophobia was negatively correlated with liking FV; liking vegetables was more predictive of neophobia level than liking fruits
Pliner & Loewen <sup>(154)</sup>	162	Children 81 pairs of siblings Age: 5–12 years 51.8 % female 48.2 % male	FNS† (10 items, 7-point scale)	Hedonic taste (liking) ratings were evaluated using a 5-point scale (good-tasting familiar foods, good-tasting novel foods, bad-tasting novel foods)	FNS scores were positively associated with liking good-tasting novel foods; FNS scores were not associated with liking good-tasting familiar foods and bad-tasting novel foods
Rodriguez-Tadeo <i>et al.</i> <sup>(23)</sup>	1491	Children and adolescents Age: 8–11 years and 12–18 years 49.5 % girls 50.5 % boys	FNS† (10 items, 7-point scale)	Actual hedonic ratings were assessed for two recipes prepared in a gastronomic workshop with a 7-point facial scale	Adolescents with higher food neophobia gave lower hedonic ratings to the recipe with vegetables and fish and similar ratings to the recipe with fruits; hedonic ratings did not differ according to neophobia in children
Coulthard & Sealy <sup>(78)</sup>	62	Children Age: 3–4 years 56.4 % girls 43.6 % boys	CFNS† (6 items, 4-point scale)	Liking was assessed using a 3-point face rating scale (8 FV: carrots, bananas, cucumbers, tomatoes, blueberries, pomegranates, kiwis and melons)	Food neophobia was inversely associated with the liking of FV

Table 1. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Maiz <i>et al.</i> <sup>(81)</sup>	165	Children Age: 8–12 years 55.1 % female 44.9 % male	Spanish FNS† (10 items, 7-point scale)	Liking of familiar foods (apples, strawberries, sponge cake and round cheeses) and unfamiliar foods (papaya, star fruit, spinach sponge cake and beetroot panna cotta) was assessed with an electronic 5-point smiley facial rating scale	Food neophobia was negatively associated with the liking of almost all familiar and unfamiliar foods, except for the liking of papaya
García-Muñoz <i>et al.</i> <sup>(140)</sup>	339	Children Age: 9–14 years 55.2 % female 44.8 % male	Italian CFNS§ (8 items, 5-point scale) ≤ 15: low 16–22: medium ≥ 23: high	Hedonic rating was assessed with 5-point hedonic smiley-scale (22 food photographs)	Food neophobia was negatively correlated with the hedonic rating for 6 of 22 foods: salmon, apples, chickpeas, beans, nuts, cured meats and sausages, and salad Unhealthy products such as candies, pastries, ice cream, sugary drinks, French fries and chicken legs were preferred by children with higher CFNS scores
Loewen & Pliner <sup>(50)</sup>	98	Children Age: 7–12 years 49 % female 51 % male	FSQ† (10 items, 5-faces scale)	Liking and familiarity were assessed using a 5-boxes scale (14 novel and familiar foods) Willingness to eat was assessed using a 5-boxes scale (24 novel and familiar foods)	Children with lower neophobia rated the foods as more familiar, liked the foods more and were more willing to eat the novel foods than those with higher neophobia
Mielby <i>et al.</i> <sup>(33)</sup>	278	Adolescents Age: 10–16 years 57.9 % female 42.1 % male	Modified FSQ‡ (10 items, 7-point scale) 10–48: Low (Neophobics) 49–58: Medium 59–70: High (Neophilics)	Expected and actual liking was assessed using a 7-point facial scale Snacks were prepared based on 4 different approaches: (1) combining colours in a snack; (2) adding energy-dense food sources to a snack; (3) combining fruits and vegetables with savoury and sweet snack products; (4) creating surprising snack combinations by adding sensory sensations not anticipated from visual cues	Food neophobics rated the expected liking of all snack combinations lower than neophilics; food neophobics rated the actual liking of all snack combinations lower than neophilics for 3 of 4 snacks
Gomes <i>et al.</i> <sup>(38)</sup>	388	Children Age: 2–6 years 49.7 % girls 50.3 % boys	CFNS† (8 items, 5-point scale) Item loadings for two opposite dimensions: food neophobia and food neophilia	Children's self-reported food preferences (liking) were assessed using a three-point facial scale (33 food pictures) Food acceptance index was calculated based on the preferences	Food neophobia was correlated with a lower liking of healthy and unhealthy foods; food neophobia was negatively correlated with acceptance index
Russell & Worsley <sup>(37)</sup>	371	Children Age: 2–5 years 46 % female 54 % male	CFNS with minor modifications†	Food preferences (liking) were assessed using a 5-point scale (176 items) The Healthy Preference Index was calculated	Food neophobia was negatively correlated with variety of food preferences and the Healthy Preference Index Food neophobia was negatively correlated with the liking of 113 of 176 food items and drinks; food neophobia was positively correlated with the number of disliked items and number of untried food items Food neophobia was negatively associated with the liking of all food groups; the strongest correlations were for the vegetable group, followed by meats and fruits

Food neophobia and dietary behaviours

Table 1. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Kähkönen <i>et al.</i> <sup>(39)</sup>	128	Children Age: 3–5 years 41.4 % female 58.6 % male	CFNS† (10 items, 7-point scale)	FV preferences (liking) were assessed using a 5-point scale (43 items); results for 28 FV were presented	Food neophobia showed a negative association with children's preferences for strong-tasting vegetables and berries and sweet-tasting fruits Food neophobia was not associated with children's preferences for common vegetables
Skinner <i>et al.</i> <sup>(41)</sup>	70	Children and mothers Age: 8 years	FNS† Mothers: 10 items, 7-point scale Children: 10 items, 3-point scale	Food preferences were assessed for mothers on a 6-point scale (196 food items, 3 alcoholic beverages) The child's food preferences (parental report) were assessed on a 6-point scale (196 food items)	Food neophobia was positively correlated with the number of never-tasted foods among both children and mothers Food neophobia was negatively correlated with the number of foods liked and positively correlated with the number of foods disliked among both children and mothers
Kaar <i>et al.</i> <sup>(42)</sup>	210	Children Age: 3–5 years 51.4 % girls 48.6 % boys	CFNS† (10 items, 5-point scale)	Food preferences (liking and eating) were assessed using a 5-point scale (80 items)	Food neophobia was associated with fewer FV and non-core food preferences among boys; it was not associated with core food preferences or sweet beverages among boys Food neophobia was associated with fewer vegetable and core food preferences among girls; it was not associated with the preference for non-core foods and sweet beverages among girls
Appiani <i>et al.</i> <sup>(96)</sup>	Children: 147 Adults: 70	Children Age: 6–13 years 49.7 % female 50.3 % male Adults Age: 19–33 years 52.9 % female 47.1 % male	Child-friendly version of FNS† (8 items, 5-point scale) FNS† (10 items, 7-point scale)	The preferences of the children's food texture were assessed by asking about the preferred item among food pairs (17 pictures of food pairs) Adults' food texture preferences were assessed by asking about the preferred item among food pairs (17 pictures of food pairs)	Both children and adults with higher food neophobia preferred softer foods
Cappellotto & Olsen <sup>(97)</sup>	70	Children Age: 6–13 years 41.4 % girls 58.6 % boys	Reduced version of the FNS† (6 items, 5-point scale)	Child Food Texture Preference Questionnaire Participants indicated the preferred item between 17 pairs of foods differing in texture; stimuli products varied in hardness and particle content	More neophobic children tended to prefer softer and non-particulate textures
Pliner <sup>(29)</sup>	103	Children Age: 5, 8 and 11 years	FNS† (10 items, 7-point scale)	Willingness to taste was assessed using a 7-point scale (20 novel and 10 familiar foods)	The child's willingness to taste unfamiliar foods was associated with the child's FNS score
Moding & Stifter <sup>(65)</sup>	82	Children Age: 4.5 years	FNS for Children (FNS-C) † (6 items, 4-point scale)	Willing to taste was assessed using a 4-point scale (3 novel foods)	More neophobic children wanted to try fewer novel foods
Wetherill <i>et al.</i> <sup>(60)</sup>	146	Children Age: 3–6 years 55.2 % female 44.8 % male	CFNS† (6 items, 4-point scale)	Farfan-Ramirez willingness to try (6 food items)	There were weak inverse correlations between food neophobia and willingness to try all vegetables
Mustonen & Tuorila <sup>(64)</sup>	164	Children Age: 8 and 11 years 55.2 % female 44.8 % male	FNS† (10 items, 7-point scale)	Willingness to try unfamiliar foods was assessed by the question 'Would you like to taste this food?' (10 food items)	Food neophobia was negatively correlated with the number of unfamiliar foods that the children were willing to try

Table 1. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Kähkönen <i>et al.</i> <sup>(89)</sup>	130	Age: 3–5 years Education group: 52.9 % girls 47.1 % boys Reference: 40.3 % girls 59.7 % boys	FNS† (10 items, 7-point scale)	Willingness to choose and willingness to eat were assessed by analysing what the children had chosen and eaten from a snack buffet (11 items – vegetables, berries and fruits)	Children’s food neophobia was negatively associated with willingness to choose and eat from the snack buffet
Koivisto-Hursti & Sjöden <sup>(155)</sup>	722	Children and their families Age: 7–17 years	FNS† (10 items, 7-point scale)	Willingness to eat/serve was assessed using a 5-point scale for foods never eaten or had eaten only a few times	FNS scores were negatively correlated with the number of foods unlike to taste among children and mothers but not among fathers

FNS, Food Neophobia Scale; CFNS, Child Food Neophobia Scale; FSQ, Food Situations Questionnaire.

\* All types of liking ratings including general food liking, expected liking (before tasting) and actual liking (after tasting) were presented.

† FNS score was used as a continuous variable.

‡ FNS scores were divided into three groups according to tertiles.

§ FNS scores were divided into three groups according to quartiles.

**Table 2.** Studies investigating the relationship between food neophobia and food familiarity, food hedonics and food preferences in adults and the elderly

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Agovi <i>et al.</i> <sup>(84)</sup>	120	Adults Age: 20–24 years 72.2 % women 17.8 % men	FNS† (10 items, 7-point scale)	Liking of vegetables was assessed using a 9-point scale	Food neophobia was negatively associated with liking both appealing (sweet and mild flavours) and unappealing (bitter, astringent and pungent flavours) vegetables
Bajec & Pickering <sup>(17)</sup>	127	Adults Age: 18–68 years 66.1 % female 33.9 % male	Modified FNS (10 items, 7-point scale) The cut-off point was determined as half of the maximum possible score. < 35: Non-neophobics ≥ 35: neophobics	Liking was assessed using a 7-point scale (332 items) Comparisons were conducted based on 6-n-propylthiouracil (PROP) taster status	Neophobics, regardless of PROP taster status (super/non taster) reported a higher liking of yogurt and milk than non-neophobics Non-neophobic PROP supertasters reported a higher liking of the FV and meat food groups than neophobic PROP supertasters Neophobics PROP supertasters reported a higher liking of the sweet and fatty food groups than non-neophobics PROP supertasters Non-neophobics PROP non-tasters reported a higher liking of the sweet and fatty food groups than neophobics PROP non-tasters
Costa <i>et al.</i> <sup>(5)</sup>	223	Adults and the elderly Age: 18–84 years 59.6 % female 40.4 % male	FNS† (10 items, 7-point scale)	Liking was assessed using a 5-point scale (10 food groups)	Food neophobia was inversely associated with the liking of FV, game meat, oily fish, seafood, fish soup, tomato soup, creamy seafood soups and some traditional dishes
Jaeger <i>et al.</i> <sup>(73)</sup>	8906	Adults Age: 18–69 years Data from 8 different studies were conducted in 5 countries	FNS† (10 items, 7-point scale; 6 items, 7-point scale for the US sample)	Liking was assessed using a 9-point scale (219 items)	Food neophobia was inversely associated with the liking of the majority of the 219 considered food and beverage items Food and beverages that were unfamiliar had strong flavours, were perceived as dangerous or belonged to other cultures, showing the strongest negative relationship between food neophobia and liking There were weakly positive correlations between liking food and beverages with low arousal properties (familiarity, sweetness, mild flavours) and food neophobia
Monteleone <i>et al.</i> <sup>(83)</sup>	1225	Adults Age: 18–60 years 61.3 % female 38.7 % male	FNS† (10 items, 7-point scale)	Liking was assessed using a 9-point scale; results of only two selected scores, liking for arugula (rocket) and radish salads, were presented	Food neophobia was negatively associated with the liking of salad with arugula and radish
Romaniw <i>et al.</i> <sup>(16)</sup>	71	Adults and the elderly Age: ≥ 60 years 73.2 % female 26.8 % male	FNS§ (10 items, 7-point scale) 16–30: low 31–48: high	Liking (appearance, flavour, texture, overall) was assessed using a 9-point scale with actual foods (10 nutrient-dense items)	There were no differences in overall liking of foods according to food neophobia groups, except mulligatawny soup, which was less liked by participants with high food neophobia
Siegrist <i>et al.</i> <sup>(79)</sup>	4436	Adults and the elderly Age: 21–99 years 52.8 % female 47.2 % male	FNS with minor modification† (10 items, 7-point scale)	Liking was assessed using a 6-point scale (6 food groups)	Food neophobia was negatively correlated with the liking of vegetables, whole-grain bread, crisps, salty nuts and salty snacks; food neophobia was not significantly associated with the liking of fruits, cookies, chocolate, candies and candy bars



Table 2. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Tuorila <i>et al.</i> <sup>(74)</sup>	121	Adults Age: Not reported	FNSII (10 items, 7-point scale) 10–22: low (neophilics) 23–29: medium 30–54: high (neophobics)	Expected liking, actual liking and the likelihood of consuming the product in the future were assessed using a 9-point scale (2 novel foods)	Expected and actual liking of novel foods was higher in neophilics than in neophobics; neophilics rated the likelihood of consuming novel foods in the future higher than did neophobics
Jaeger <i>et al.</i> <sup>(18)</sup>	1167	Adults and the elderly Age: 18–72 years 59% female 41% male	FNS† (10 items, 7-point scale)	Food preference (liking) was assessed using a 9-point scale (112 items) Five discrete factors (vegetables, meat/processed, wine/antipasto, seafood, beverages) were determined	Food neophobia was associated with a lower level of preference for nearly half of the food items Food neophobia was associated with a lower preference for common dietary items such as coffee, mushrooms, zucchini (courgettes), pork and some seafood Lower preferences were determined for each of the factors with high food neophobia
Murray <i>et al.</i> <sup>(14)</sup>	75	Adults Age: 18 to ≥ 55 years European-origin Australian: 52.6% female 47.4% male Chinese-origin Australian: 73% female 27% male	FNS§ (10 items, 7-point scale) FNS for Europeans 10–27: neophilics 28–43: neophobics FNS for Chinese 18–27: neophilics 29–46: neophobics	The preferences of 6 extruded snack samples (representing 'novel' products in both cultures and differing in their textures) were evaluated on 150 mm line scales anchored at each end with 'like extremely' and 'dislike extremely'	Food neophobia classification was not associated with preferences for snacks with different textures
Çinar <i>et al.</i> <sup>(40)</sup>	9319	Adults (twins and siblings of twins) Age: 18–58 years	Meat and plant neophobia† (12 meats, 12 plants images, 4-point scale)	Preferences (liking) for 6 plants and 6 meat samples were assessed using a 7-point scale	Meat neophobia was negatively correlated with meat and plant preference. The association between meat neophobia and meat preference was stronger than plant preference Plant neophobia was negatively associated with plant and meat preferences. The association between plant neophobia and plant preference was stronger than meat preference
Laaksonen <i>et al.</i> <sup>(57)</sup>	357	Adults Age: 20–72 years 77% female 23% male	FNS‡ (10 items, 7-point scale) 10–19: low 20–31: medium 32–68: high	Liking of berries was assessed using a 9-point scale (14 items) Familiarity with berries was assessed using 5-point scales	The most neophobic group gave lower liking ratings for 8 berries compared with less neophobic groups; the most neophobic group gave lower familiarity ratings for 7 berries compared with less neophobic groups

Food neophobia and dietary behaviours

Table 2. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Laureati <i>et al.</i> <sup>(49)</sup>	1225	Adults Age: 20–60 years 61% female 39% male	FNS¶ (10 items, 7-point scale) ≤ 18: neophilic 19–35: medium ≥ 36: neophobic	Familiarity was assessed using a 5-point scale Liking was assessed using a 9-point scale (16 vegetables, 13 beverages, 15 sweets/desserts)	Food neophobia was inversely associated with the liking of many vegetables, especially those with a strong taste Familiarity was not different according to food neophobia levels except for 3 strong-tasting vegetables, which were less familiar among neophobics Highly neophobic participants liked strong-tasting beverages less and sweetened tea and soft drinks more compared with less neophobic participants Strong-tasting beverages were less familiar to highly neophobic participants than less neophobic Generally, food neophobia was not associated with familiarity with or liking of sweets and desserts, although there were some exceptions
Fenko <i>et al.</i> <sup>(47)</sup>	327	Adolescents and adults Age: 16–57 years 68% female 32% male	FNS† (10 items, 5-point scale)	Familiarity with soya products was assessed using a 5-point scale with 3 questions Liking was assessed using a 5-point scale with four questions Willingness to try was assessed using a 5-point scale with 3 questions	Individuals with higher food neophobia showed lower willingness to try soya products than those with lower food neophobia Individuals with higher food neophobia liked familiar foods more than unfamiliar foods Individuals with higher food neophobia had lower liking scores for unfamiliar soya products than those with lower food neophobia
Januszewska & Viaene <sup>(85)</sup>	Total: 389 Małopolska, Poland: 196 East Flanders, Belgium: 193	Adults Age: 20–60 years Małopolska: 53.6% female 46.4% male East Flanders: 65.8% female 34.2% male	FNSII (10 items, 7-point scale)	Overall liking was evaluated using a 5-point scale and likings of colour, odour and taste were assessed using a 9-point scale (8 traditional Polish food products and 8 traditional Flemish food products) Willingness to buy was assessed using a 5-point scale	Usually, neophobics rated lower overall liking, sensory liking and willingness to buy new traditional foods than variety seekers
Spinelli <i>et al.</i> <sup>(69)</sup>	1146	Adults Age: 18–60 years 61% female 39% male	FNS† (10 items, 7-point scale)	Liking of chili and pungent foods was assessed using a 9-point scale The choice was assessed using a pair of items selected among 5 food-pair options (pungent: with spice, non-pungent: without spice) A choice index for pungent food was calculated	Food neophobia was negatively associated with the liking of hot chili pepper Food neophobia was negatively correlated with the pungent food choice index
Sharafi <i>et al.</i> <sup>(82)</sup>	167	Adults Age: 23 years 52.7% female 47.3% male	A revised FNS† (10 items, 5-point scale)	Liking was evaluated using a general visual analogue scale (47 foods/beverages) Healthy Eating Preference Index was calculated	Individuals with higher food neophobia had lower liking for FV, proteins and wine and fewer healthy foods Food neophobia was negatively associated with the Healthy Preference Index in preterm adults only, not term ones

Table 2. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Raudenbush & Frank <sup>(48)</sup>	33	Adults Age: 18–49 years 63.6 % female 36.4 % male	FNS** (10 items, 7-point scale)	Familiarity, willingness to try and expected liking were assessed using a 11-point scale (10 items) Actual liking and willingness to try again in the future were assessed using a 11-point scale after foods were sampled	Food neophobia was not associated with the familiarity ratings for 7 out of 10 foods Food neophobia was not associated with expected liking or willingness to try of familiar foods; however, expected liking and willingness to try unfamiliar foods ratings were lower among neophobics compared with neophilics Food neophobia was not associated with actual liking ratings of familiar foods; however, actual liking ratings of unfamiliar foods were lower among neophobics compared with neophilics Neophilics were more willing to try the foods again than were the neophobics
Raudenbush <i>et al.</i> <sup>(63)</sup>	Experiment 1: 102 Experiment 2: 263	Experiment 1: Mean age: 20.3 years 69.6 % female 30.4 % male Experiment 2: Age: 10–55 years 50.6 % female 49.4 % male	FNSII (10 items, 7-point scale)	Experiment 1: Willingness to try novel foods and liking of familiar foods were assessed using a 5-point scale (132 items) Experiment 2: Actual choice experiment with 3 types of jars, including lemon, orange and mystery. The 'mystery jar' contained cherry and banana-flavoured beans	Experiment 1: Food neophobia was negatively correlated with the willingness to try novel foods and negatively correlated with the number of foods the participants reported having tried in the past. Food neophobia was not associated with the liking of familiar foods Experiment 2: The 'mystery' flavour was chosen less by neophobics compared with neophilics
Potts & Wardle <sup>(156)</sup>	Study 1: 72 Study 2: 92	Study 1: Adults University students Study 2: Adults Mothers of 9–11-year-old children	FNS† (10 items, 7-point scale)	Study 1: The participants were asked the question, would they be happy to eat foods in the list, and the number of foods that were answered 'no' was calculated as the number of rejected foods (58 food items; real foods, novel foods, animal non-foods, plant non-foods) Study 2: Liking scores were assessed using a 5-point scale (30 items)	Study 1: FNS scores showed positive correlations with the number of rejected real foods, novel foods, animal non-foods and plant non-foods Study 2: Food neophobia was positively associated with the number of disliked foods. Food neophobia was not associated with the number of disliked meats or disliked vegetables
Pliner & Hobden <sup>(2)</sup>	Sample 1: 39 Sample 2: 34 Sample 3: 29	Adults Age: 18–74	FNS† (10 items, 7-point scale)	Sample 1: Familiarity was assessed using a 6-point scale Sample 1: 30 food items: 15 unfamiliar – 15 familiar Sample 2: 10 food pairs: 5 unfamiliar – 5 familiar Sample 3: 7 good- or bad-tasting novel or familiar foods were tasted and liking ratings	Sample 1: More neophobic subjects reported being less familiar with unfamiliar foods. FNS scores were not significantly correlated with the familiarity for the familiar foods Sample 2: More neophobic subjects were less willing to taste novel foods than subjects lower in neophobia Sample 3: FNS scores were correlated with familiarity for unfamiliar foods, but not with familiarity for the familiar foods Sample 3: Subjects with high and low food neophobia did not differ in terms of their liking for the foods they tasted
Hwang & Lin <sup>(52)</sup>	40	Adults and the elderly Age: 19–83 years 70 % females 30 % males	FNS† (10 items, 7-point scale)	Familiarity with foods was assessed using a 7-point scale (pictures of 20 Asian menu items)	Food neophobia was inversely associated with familiarity with Asian foods among Americans

Food neophobia and dietary behaviours

Table 2. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Knaapila <i>et al.</i> <sup>(53)</sup>	126	Adults Age: 25–61 years 73.8 % female 26.2 % male	FNS† (10 items, 7-point scale)	Familiarity with spice/herbs was assessed (38 items)	Food neophobia was negatively correlated with the total number of different spices consumed
De Toffoli <i>et al.</i> <sup>(56)</sup>	1200	Adults Age: 18–60 years 58 % female 42 % male	FNS¶ (10 items, 7-point scale)	Vegetable choices with different bitterness and astringency were evaluated by asking the preferred item among food pairs (7 pairs) Coffee/tea choices with differing bitterness and astringency were assessed by asking the preferred item among beverage pairs (3 pairs) Familiarity with vegetables and coffee/tea was assessed using a 5-point scale	Individuals with higher levels of food neophobia preferred bitter/astringent items less than those with lower food neophobia Neophobic individuals were less familiar with vegetables Neophobic individuals were less familiar with bitter/astringent coffee/tea options
Choe <i>et al.</i> <sup>(51)</sup>	416	Adults Age: 20–40 years	FNS† (10 items, 7-point scale)	Familiarity and willingness to try were assessed using a 7-point scale (12 non-traditional ethnic food items)	Food neophobia was negatively correlated with familiarity or willingness to try most non-traditional foods
Olabi <i>et al.</i> <sup>(45)</sup>	1122	Adults Age: 20.9 ± 4.7 years 55.6 % female 44.4 % male	FNS¶ (10 items, 7-point scale) ≤ 18: low (neophilic) 19–35: medium ≥ 36: high (neophobics)	Familiarity and willingness to try were assessed using a 5-point scale (15 items)	Subjects with low neophobia tried 11 more food items than those with high neophobia Food neophobia was negatively correlated with the willingness to try food items; these correlations were stronger for new foods compared with familiar foods
Martins <i>et al.</i> <sup>(54)</sup>	80	Adults Undergraduate university students 50 % female 50 % male	FNS† (10 items, 7-point scale)	Familiarity and willingness to try were assessed using a 7-point scale (14 food pairs, novel vs familiar)	Adults with lower food neophobia were more willing to try new foods and they rated the foods as more familiar than those with a higher food neophobia
Tuorila <i>et al.</i> <sup>(55)</sup>	1083	Adults and the elderly Age: 16–80 years	FNS† (10 items, 7-point scale)	Familiarity and willingness to try were assessed using a 5-point scale (20 items, familiar and unfamiliar foods)	Food neophobia was inversely associated with familiarity with 13 foods; food neophobia was inversely associated with the willingness to try both familiar (in most cases) and unfamiliar foods
Dibbets <i>et al.</i> <sup>(46)</sup>	117	Adults Age: 21.45 ± 4.48 years 74.4 % female 23.1 % male 2.6 % not specified	FNS† (10 items, 7-point scale)	Willingness to try was assessed using a visual analogue scale (0–100) with 4 unfamiliar fruit pictures	Food neophobia was negatively correlated with willingness to eat all unfamiliar fruits
Stratton <i>et al.</i> <sup>(44)</sup>	200	Adults and the elderly Age: > 60 years 70 % female 30 % male	FNS† (10 items, 7-point scale)	Willingness to try functional foods was assessed using a 5-point scale	Higher food neophobia was associated with less willingness to try new functional foods
Schickenberg <i>et al.</i> <sup>(72)</sup>	326	Adults Age: 18–50 years 56.4 % female 43.6 % male	FNS† (10 items, 7-point scale)	Willingness to try was assessed using a 5-point scale (15 healthy alternatives of traditional food items) Acquaintance was assessed using yes/no answers (15 healthy alternatives of traditional food items)	Food neophobia was negatively associated with a mean willingness to try healthy food alternatives Food neophobia was negatively associated with acquaintance with healthy food alternatives
Knaapila <i>et al.</i> <sup>(90)</sup>	1175	Adults Age: 20–25 years 54.7 % female 55.3 % male	FNS† (10 items, 7-point scale)	Pleasantness was assessed using a 7-point scale (49 items)	Food neophobia was negatively correlated with the perceived pleasantness of fish, FV and berries; food neophobia was negatively correlated with sweet and fatty foods only among women

Table 2. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of food familiarity, food choice and food liking*	Findings
Mattes <sup>(86)</sup>	20	Adults Age: 29.6 ± 9.0 years 50 % male 50 % female	FNS† (10 items, 7-point scale)	Pleasantness ratings were assessed using a 9-point scale (sweet, salty, sour and bitter foods)	Food neophobia was negatively associated with pleasantness ratings for sour foods
El Dine & Olabi <sup>(67)</sup>	82	Adults Age: 18–54 years 72 % female 28 % male	FNS** (10 items, 7-point scale)	Acceptability of foods was assessed using a 9-point scale or a 10-cm vertical labelled affective magnitude scale (10 food items, 5 novel and 5 familiar)	There was a difference for two unfamiliar foods (pickled ginger and lychee); the neophobic group accepted these foods less compared with the neophilic group
Olabi <i>et al.</i> <sup>(58)</sup>	Study 1: 22 Study 2: 45	Adults Age: 18–26 years 45.5 % female 54.5 % male Study 2: Age: 18–27 years 80 % female 20 % male	FNS†† (10 items, 7-point scale)	Study 1: Acceptability of foods was assessed using a 9-point scale (4 familiar foods prepared in two versions: an original version and a more flavourful version) Study 2: Acceptability of foods was assessed using a 9-point scale (8 foods consisting of novel and familiar foods and prepared in two versions: an original version and a more flavourful version) Familiarity with foods was assessed using a 9-point scale	Study 1: Food neophobia did not have a significant effect on the acceptability of familiar samples; food neophobia and complexity interaction were significant; food neophobics gave lower ratings to flavourful foods than bland familiar foods Study 2: Familiarity ratings were higher among food neophilics compared with food neophobics; mean acceptability ratings for both familiar and novel foods were higher among food neophilics compared with neophobics; food neophobia and complexity interaction was not significant, although there was a trend similar to Study 1
Guzek <i>et al.</i> <sup>(94)</sup>	600	Adults Age: 18–30 years 100 % women	FNS†† (10 items, 7-point scale) 10–19: low 20–40: average 41–70: high	Web-based choice experiment using a mock Italian restaurant menu Four categories: starter, soup, main course and dessert (two or three different dishes in each category, at least one dish in each category with neophobic potential)	Food neophobic participants less commonly chose dishes with neophobic potential
Guzek <i>et al.</i> <sup>(67)</sup>	601	Adults Age: 18–30 years 70.7 % women 29.3 % men	FNS‡ (10 items, 7-point scale) 10–26: low 26–36: average 36–61: high	Web-based choice experiment using a mock Vietnamese restaurant menu Four categories: starter, soup, main course and dessert (three different Vietnamese dishes in each category, one dish in each category with neophobic potential)	Food neophobic participants chose fewer dishes with neophobic potential
Guzek & Głabaska <sup>(95)</sup>	203	Adults Age: 18–40 years 100 % women	FNS‡ (10 items, 7-point scale) 10–24: low 25–35: average 36–64: high	Web-based choice experiment using a mock French restaurant menu Four categories: starter, soup, main course and dessert (four dishes in each category, two dishes in each category with neophobic potential)	Individuals with higher food neophobia chose fewer dishes with neophobic components and/or animal-based components
Schickenberg <i>et al.</i> <sup>(157)</sup>	396	Adults Age: 20.6 ± 2.1 years 73 % women 27 % men	FNS† (10 items, 7-point scale)	Actual choice experiment with 4 food products and their healthy alternatives (low-fat cheese, very low-fat margarine spread, fruit juice, FV juice)	Food neophobia was not associated with the choice of the offered healthy alternative products

FNS, Food Neophobia Scale.

\* All types of liking ratings including general food liking, expected liking (before tasting) and actual liking (after tasting) were presented.

† FNS score was used as a continuous variable.

‡ FNS scores were divided according to tertiles.

§ Median score.

|| It is not clear how the cut-off points of FNS score was determined.

¶ Quartiles.

\*\* FNS score was categorised based on the cut-off scores of another study.

†† Mean ± sd.

vegetables have a bitter taste. It has been determined that neophobic individuals avoid intense aromas and pungent, astringent or bitter tastes<sup>(49,56,58,69,73)</sup>. While humans innately prefer sweet tastes, an appreciation of bitter and sour tastes can only be learned by repeated exposure<sup>(92)</sup>. However, according to Knaapila *et al.*<sup>(27)</sup>, food neophobics may often refuse to retry foods that they did not like at the first bite, such as vegetables, whereas food neophilics may be willing to try such foods again. Therefore, neophilics may learn to like vegetables more easily than neophobics. Furthermore, most poisonous substances in nature have a bitter taste, so it is argued that natural defence mechanisms in the subconscious reject many vegetables with a bitter taste<sup>(93)</sup>.

Few studies have investigated the association between food neophobia and food preferences. Food neophobia was reported to be negatively correlated with healthy preferences in both children<sup>(37)</sup> and adults<sup>(82)</sup>. Adults with higher food neophobia preferred less bitter/astringent food items<sup>(56)</sup> and preferred fewer dishes with neophobic potential<sup>(67,94,95)</sup>. The food textures preferred by individuals may also differ according to the food neophobia statuses of those individuals. Appiani *et al.*<sup>(96)</sup> found that food neophobia was negatively associated with preferences for hard foods in children. Another study reported that children who preferred softer and non-particulate versions of foods were more neophobic<sup>(97)</sup>. However, no differences were observed between adults<sup>(14)</sup>. The relationship between texture and food refusal may be specific to the childhood period; however, studies on this topic are too limited for a firm conclusion to be drawn.

In summary, studies consistently indicate that food neophobia is negatively correlated with familiarity and the hedonics of many food items and it affects food preferences. These relationships are considerable factors contributing to the association between food neophobia and dietary intake that will be discussed below.

**The relationship between food neophobia and motivations for food choices.** 'Food choice' is an umbrella term used to define behaviours and factors that exist before the consumption of food<sup>(34,35)</sup>. Factors influencing food choice can be grouped into three main categories: food-related features (e.g. sensory features and packaging), individual differences (e.g. knowledge and preference) and society-related features (e.g. culture and policy)<sup>(35)</sup>. Food neophobia is just one of the individual differences that affect food choices.

Consumers with different levels of food neophobia exhibit different decision-making processes<sup>(98)</sup>. Several studies have examined the relationship between consumer motivations for food choices and food neophobia. The Food Choice Questionnaire, which includes the nine factors of health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity and ethical concern, has primarily been used in such studies. Jaeger *et al.*<sup>(18)</sup> conducted a study with adults in New Zealand (*n* 1167) and found that convenience and familiarity were important factors in food choice, which was positively associated with food neophobia. Later, Jaeger *et al.*<sup>(99)</sup> investigated the same relationship based on data obtained from four different studies conducted in three different countries (USA, Australia and New Zealand) and found that as consumers' levels

of food neophobia increased, the importance given to familiarity, convenience and price (the latter only in the Australian population) increased. To replicate these results, an online survey was administered to 5752 adults from the USA, UK and Germany and, in joint analysis, food neophobia was positively associated with the importance given to familiarity, convenience and price, although there were cross-cultural differences<sup>(100)</sup>. Convenience and familiarity were also reported as important factors in different studies<sup>(68,101)</sup>. A food-choice experiment study demonstrated that familiarity (neophobic potential) was the major determinant of food choice<sup>(94)</sup>. These results are not surprising considering the negative relationships between food neophobia and the familiarity and hedonics of unfamiliar foods (see the 'The relationship between food neophobia and food familiarity, food hedonics and food preferences' section).

Among the other motivations for food choice, the naturalness of food contents and the importance of health aspects of food were generally inversely associated with food neophobia in large-scale cross-sectional studies<sup>(99,100)</sup>. However, food-preference experiment studies did not support this association. In one of these studies, there was no relationship between food neophobia and perceived health<sup>(94)</sup>, while, in another, health was a more important motivator for neophobics than taste<sup>(13)</sup>. This difference in experimental studies can be explained by the difference between food preference and food choice. Food preference is only one of the factors that affect food choice, and food choice is a dynamic process; different factors (such as physical accessibility, price, convenience and food preference) affecting food choice also affect each other in this process. The findings on other motivations are quite contradictory<sup>(99–101)</sup> and do not reflect dominant factors in terms of food choice related to food neophobia<sup>(99)</sup>.

Overall, food neophobia affects individuals' daily food choice decisions. Familiarity and convenience are more prominent motivators in food choices for individuals with high food neophobia, while health and natural contents are less important. These points suggest that food neophobia is a potential barrier to healthy food choices.

**The relationship between food neophobia and dietary intake.** Dietary intake generally refers to all foods and beverages consumed orally<sup>(102)</sup>. Dietary intake is assessed through subjective reports and direct observations. Direct observations are not a suitable dietary assessment method for large-scale studies, however, as food consumption is recorded by well-trained research staff. Therefore, in most studies, the dietary intake of individuals is determined using subjective assessments, with open-ended questionnaires, such as 24-h dietary recalls or dietary records, or with closed-ended questionnaires such as FFQ. However, all dietary assessment methods have some limitations, such as social desirability bias and the Hawthorne effect. Additionally, subjective reports have limitations such as recall and interviewer bias<sup>(34,103)</sup>.

Studies exploring the relationship between food neophobia and dietary intake in children and adolescents are given in Table 3. It should be noted that dietary intake was assessed by subjective methods in almost all these studies. Food neophobia has been linked with the consumption of many foods and



food groups that are recommended to be consumed daily in our diets. In this respect, the relationship between vegetables and fruits and neophobia has been revealed in many studies. Most of such studies have consistently shown that children or adolescents with higher levels of food neophobia consume fruits and vegetables (FV) less frequently<sup>(8,15,20–22,96,104–106)</sup> and in lower amounts<sup>(7,15,78,107–111)</sup>. They also have a lower variety of FV in their diets<sup>(112)</sup>. Some studies reported this association only for vegetables<sup>(6,19,23,30,31,113,114)</sup>. Only one study conducted with Brazilian adolescents found no association between food neophobia and FV consumption<sup>(24)</sup>. The insufficient intake of FV in the entire study group and the low food neophobia scores of the group may be linked with that lack of association. There is also a negative association between food neophobia and consumption of animal protein sources, especially meat and its derivatives. Generally, the consumption of red meat<sup>(20)</sup>, eggs<sup>(8)</sup>, chicken<sup>(20,108)</sup> and fish<sup>(20,22,104)</sup> was negatively associated with food neophobia, although there are also reports that indicate no association for eggs<sup>(20)</sup>, meat<sup>(104)</sup> and fish<sup>(23)</sup>.

The relationship between food neophobia and less frequent consumption of FV and meats has also been supported from a different perspective. Positive correlations were found between food neophobia and plant neophobia and meat neophobia<sup>(115)</sup>. One of the explanations for the association between food neophobia and less frequent consumption of FV and animal products may be sensory sensitivity. How neophobics interpret visual cues and their disgust sensitivity may be factors involved in the consumption of these foods. Even visual cues from foods that do not 'look right' may lead to the rejection of foods. Moreover, other sensory properties of foods including bitter tastes, strong odours and hard textures may also contribute to food refusal. Another explanation is that these foods may be perceived as potentially poisonous plants or animals, which was a life-saving attitude in hunter-gatherer days. Another reason for the lower acceptance and consumption of these foods, especially vegetables, may be related to the fact that these foods do not have innately liked sensory properties, such as sweet and salty tastes and fatty mouthfeel. Furthermore, individuals' pathogen-related disgust sensitivity and germ-aversion behaviours may play roles in meat neophobia since meats have higher microbial loads and deteriorate faster than other foods. The association of meat consumption with masculinity and empathy with animals may also be potential explanations for neophobic behaviours towards meat. Despite all these hypotheses, however, it is not exactly clear why children refuse these foods. Further studies conducted with qualitative research methods may provide a better understanding of the drivers of FV and meat rejection among neophobics.

The results on milk and dairy products<sup>(15,20,25,81,108)</sup>, grains<sup>(15,21,22,108)</sup> and sweets/snacks are inconsistent<sup>(8,15,20–24,96,104,108)</sup>. Population-based differences in dietary habits, the variety among methods for assessing dietary consumption and the discrepancies in the definitions of food groups such as 'snacks' may be partly responsible for these different results.

Studies investigating food neophobia and dietary diversity have consistently found that children with higher levels of food neophobia have lower dietary diversity<sup>(20,28,31,38,116,117)</sup>. However, there are few studies investigating the dietary variety

of adolescents<sup>(116,118)</sup>. One of them was conducted with German adolescents and neither overall nor core food dietary variety differed according to the neophobia status of the participants. Only a trend towards limited core food variety was detected among boys with higher levels of food neophobia<sup>(118)</sup>. Another study conducted with type 1 diabetics reported a negative association between food neophobia and dietary variety<sup>(116)</sup>. The less frequent intake of core food groups among neophobic individuals probably leads to reduced dietary diversity.

Although some studies<sup>(28,119)</sup> have not found an association between food neophobia and nutrient intake, most studies have shown that energy intake and macro- and micronutrients differ significantly according to levels of food neophobia. Findings on the relationship between food neophobia and energy intake are contradictory<sup>(8,15,28,108)</sup>. Food neophobia was associated with lower protein intake<sup>(15,118)</sup> and the percentage of total energy intake from protein<sup>(26)</sup>. The carbohydrate intake of neophobic preschool children was found to be significantly higher compared with neophilics<sup>(8)</sup>. The findings related to micronutrient intake have been slightly more consistent, showing that children with higher food neophobia had lower intake of many micronutrients<sup>(8,60,108,120)</sup>. Kozio-Kozakowska *et al.*<sup>(8)</sup> indicated that neophobic children had significantly lower thiamine intake than neophilics, and there was a negative correlation between the level of food neophobia and vitamin C intake. Food-neophobic preschool children met 84% of the recommended thiamine intake, 47.5% of the recommended folate intake and only 36% of the recommended vitamin C intake because they rarely ate vegetables. For neophilic children, these values were found to be approximately 99, 53 and 68%, respectively. Kutbi *et al.*<sup>(26)</sup> found a lower intake of various minerals, including K, P, Mg, Fe, Zn, and Se, among neophobic children aged 6–12 years. Gan *et al.*<sup>(15)</sup> reported similar results among children aged 7–10 years. Overall, it may be argued that protein intake, vitamin intake and mineral intake are all sensitive to food neophobia. However, the results regarding energy intake are contradictory and need further verification. Since studies on the adolescence period are limited, more studies are needed to interpret the relationship between food neophobia and macro- and micronutrient intake.

When all these relationships between food neophobia and food and nutrient intake are evaluated, it is not surprising that food neophobia is negatively associated with the quality of diet. As can be seen in Table 3, studies have reported that children and adolescents with higher levels of food neophobia have poorer diet quality<sup>(22,23,28,116,121,122)</sup>. Rodriguez-Tadeo *et al.*<sup>(23)</sup> and Maiz and Balluerka<sup>(22)</sup> determined that there was an inverse linear relationship between the degree of food neophobia and adherence to the Mediterranean diet. There was a negative correlation between food neophobia and the Healthy Eating Index score<sup>(116)</sup>, and the Healthy Eating Index scores of neophobic children were significantly lower than the average and those obtained for neophilic children<sup>(28)</sup>. Bell *et al.*<sup>(121)</sup> also calculated dietary risk scores using portion sizes and frequencies of foods and found that higher food neophobia scores were associated with a higher risk for poor diet quality. The relationship between vegetarianism and food neophobia was examined in a single study conducted with adolescent girls and vegetarians were found to be more neophobic than non-vegetarians<sup>(120)</sup>.



**Table 3.** Studies investigating the relationship between food neophobia and dietary intake in children and adolescents

Authors	Sample Size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Appiani <i>et al.</i> <sup>(96)</sup>	147	Children Age: 6–13 years 49.7 % female 50.3 % male	Child-friendly version of the FNS* (8 items, 5-point scale)	Parent-reported child FFQ (13 items)	Food neophobia was inversely associated with frequency of fruit consumption (both hard and soft fruits) while it was positively associated with the consumption of foods with soft textures such as baked goods, sweets and potatoes
Appleton <i>et al.</i> <sup>(77)</sup>	736	Adolescents Age: 14.3 ± 1.6 years 51.0 % female 49.0 % male	FNS* (10 items, 7-point scale)	Regular vegetable consumption was assessed by asking about the consumption of 11 vegetables classified into two groups (less and more appealing)	FNS scores of adolescents were not significantly associated with the regular consumption of more appealing vegetables (carrots, peas, sweetcorn and tomatoes) or less appealing vegetables (broccoli, cauliflower, green salad and spinach)
Bell <i>et al.</i> <sup>(121)</sup>	206	Children Age: 1–5 years 53.9 % female 46.1 % male	CFNS* (6 items, 4-point scale)	Toddler Dietary Questionnaire (1–3 years) Preschooler Dietary Questionnaire (3–5 years)	A positive correlation was observed between food neophobia scores and dietary risk scores, confirming that children with higher levels of food neophobia had lower diet quality
Chitra <i>et al.</i> <sup>(120)</sup>	1446	Adolescent girls Age: 15–19 years	FNS with minor modifications* (10 items, 7-point scale)	Questions about the frequency of high-fat food consumption	Participants who consumed high-fat or junk foods less often were more neophobic
Cooke <i>et al.</i> <sup>(108)</sup>	109	Children Age: 4–5 years 97.2 % female 2.8 % male	CFNS* (6 items, 4-point scale)	Three tested lunchtime meals at school at weekly intervals; food items were weighed before and after a meal	Food neophobia was associated with lower consumption of fruits (grapes), vegetables (tomatoes, carrots) and protein foods (chicken, cheese); however, it was not related to intake of starch (bread rolls) or snacks (chocolate, cheese biscuits) More neophobic children consumed fewer total energy content The mean intake of FV was lower among children with higher levels of neophobia than children with lower levels of neophobia
Cooke <i>et al.</i> <sup>(106)</sup>	564	Children Age: 2–6 years 50 % female 47 % male 3 % not specified	CFNS* (6 items, 4-point scale)	Frequency of six food items' consumption, including FV	More neophobic children ate fruit ( $r = -0.16$ , $P < 0.001$ ) and vegetables ( $r = -0.27$ , $P < 0.001$ ) less often than their peers
Coulthard & Blissett <sup>(109)</sup>	73	Children Age: 2–5.4 years 45.2 % girls 54.8 % boys	CFNS* (10 items, 7-point scale)	Frequency and amount of FV consumption	Food neophobia was negatively correlated with the portion sizes of FV consumed by the children
Coulthard & Thakker <sup>(107)</sup>	70	Children Age: 2–5 years 47.1 % female 52.9 % male	CFNS* (6 items, 4-point scale)	Frequency and portion size of FV consumption	Food neophobia was negatively related to the portion sizes of the FV consumed
de Andrade Previato & Behrens <sup>(24)</sup>	132	Adolescents Age: 15–19 years 51.5 % girls 48.5 % boys	FNS* (10 items, 7-point scale)	Frequency of daily intake of sweets, soft drinks, FV	There was no association between FNS scores and consumption of sweets, soft drinks and FV; most adolescents had insufficient intake of FV
de Wild <i>et al.</i> <sup>(114)</sup>	750	Children Age: 2–6 years 47.8 % girls 52.2 % boys	CFNS* (6 items, 5-point scale)	Actual vegetable intake (pre- and post-weighing)	Food neophobia was negatively associated with vegetable intake



Table 3. (Continued)

Authors	Sample Size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Dos Anjos <i>et al.</i> <sup>(25)</sup>	214	Children Age: 3–6 years 50.5 % female 49.5 % male	CFNSII (10 items, 5-point scale) ≤ 22: low 23–37: medium ≥ 38: high	Validated semi-quantitative FFQ (9 food groups, 56 food items)	Children with high neophobia consumed ultra-processed foods and protein-rich foods (white meat, cheese, yogurt) more frequently Three dietary patterns (traditional, snacks and school snacks) were identified; neophobic children had lower adherence to the traditional dietary pattern composed of foods typical to the Brazilian diet and culture
Falciglia <i>et al.</i> <sup>(28)</sup>	70	Children Age: 9–11 years 52.9 % female 47.1 % male	FNSII (10 items, 7-point scale) < 27: food neophilic 28–40: average > 41: food neophobic	24-h recall, 3-d food intake survey (2 weekdays, 1 weekend) Healthy Eating Index (HEI)	The mean HEI score of neophobic children was significantly lower than the average and that of neophilic children Neophobics had a lower intake of saturated fat and less food variety than non-neophobics The rates of meeting two-thirds of the recommended daily intake for energy and many nutrients were found to be similar, except for vitamin E, according to levels of food neophobia; the number of neophobic children who met two-thirds of the recommended daily intake for vitamin E was found to be lower than the average and that of the neophilic group
Fernandez <i>et al.</i> <sup>(75)</sup>	Baseline: 226 Follow-up: 134	Children Baseline: Age: 70.9 ± 8.5 months 51.8 % female 48.2 % male Follow-up: Age: 101.9 ± 11.2 months 51.5 % female 48.5 % male	CFNS* (10 items, 7-point scale)	Structured Eating Protocol: participants were videotaped while being presented with individual portions of 4 different types of foods (familiar: green beans, green peas; unfamiliar: artichokes, heart of palm)	CFNS scores were inversely correlated with the quantity consumed, children's hedonic ratings and compliance with prompts to eat both familiar vegetables (baseline: green beans, follow-up: peas) and unfamiliar vegetables (baseline: artichokes, follow-up: palm) at baseline and follow-up CFNS scores were inversely correlated with the number of bites (green beans and artichokes), positively correlated with latency to the first bite (green beans and artichokes) and positively correlated with children's negative utterances (for the only familiar food: green beans)
Galloway <sup>(113)</sup>	189	Children Age: 7.3 ± 0.3 years 100 % girls	CFNS* (6 items, 7-point scale)	3-d 24-h recall (2 weekdays, 1 weekend)	Girls' CFNS scores were negatively associated with vegetable intake
Gan <i>et al.</i> <sup>(15)</sup>	321	Children Age: 7–10 years 49.8 % female 50.2 % male	Modified CFNS‡ (4 items, 5-point scale) < 12: non-neophobic ≥ 12: neophobic	The direct observation method was employed to record all visible food and beverage items consumed by each student during a typical school day	The total energetic intake in a school day was not significantly different according to the food neophobia levels of children Intake of dietary protein, fibre, folate, Mg, K, Zn and vitamins B <sub>1</sub> , B <sub>2</sub> , B <sub>3</sub> , B <sub>6</sub> , D and E was lower among neophobic children Sugar and Na intake did not differ according to food neophobia level Food neophobia was negatively associated with the consumption of vegetables and fruit, meat and alternatives No significant differences were observed between groups in the amounts of grain products, milk and alternatives, vegetable and fruit juices, sugar-sweetened beverages or snacks consumed from home-packed lunches

Table 3. (Continued)

Authors	Sample Size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Gomes <i>et al.</i> <sup>(38)</sup>	388	Children Age: 2–6 years 49.7 % girls 50.3 % boys	CFNS (8 items, 7-point scale) Item loadings for two opposite dimensions: food neophobia and food neophilia	Child's Eating Habits Questionnaire Food variability index	Food neophobia was negatively associated with healthy food consumption and dietary variety score Food neophilia was positively associated with healthy food consumption and dietary variety score
Guzek <i>et al.</i> <sup>(6)</sup>	163	Adolescents Age: 10–12 years 47.9 % girls 52.1 % boys	FNS† (10 items, 7-point scale) 1st tertile: low 2nd tertile: medium 3rd tertile: high	FFQ (31 items)	According to the FNS scores, no difference was detected in FV or FV juice intake among boys, while among girls, the only difference was in vegetable intake, which was lower among girls with higher levels of neophobia than those with lower levels of neophobia In correlation analysis, there were no significant differences in fruit, fruit juice or vegetable juice intake between food neophobia levels A negative correlation was observed between food neophobia level and vegetable intake among both boys and girls
Guzek <i>et al.</i> <sup>(7)</sup>	507	Adolescents Age: 12–13 years 58.6 % girls 41.4 % boys	FNS (10 items, 7-point scale) FNS score was divided into three equal groups 10–30: food neophilic 30–50: neutral 50–70: food neophobic CFNS*	FFQ (31 items)	Higher food neophobia was associated with lower FV intake among both boys and girls
Helland <i>et al.</i> <sup>(104)</sup>	505	Toddlers Age: 27.9 ± 3.5 months 46.9 % girls 53.1 % boys	CFNS* (6 items, 7-point scale)	FFQ (46 items)	Toddlers with higher food neophobia had a lower intake of fish, berries, FV There was no significant relationship between food neophobia score and intake of meat or sweet and salty snacks
Jarman <i>et al.</i> <sup>(122)</sup>	228	Children Age: 2–5 years 51 % girls 49 % boys	CFNS* (6 items, 4-point scale)	FFQ (20 items) Diet quality was assessed using a validated FFQ	Children with higher food neophobia had poorer diet quality
Johnson <i>et al.</i> <sup>(31)</sup>	180	Children Age: 4 years 54.5 % girls 45.5 % boys	FNS* (10 items, 7-point scale)	Block Kids Food Screener (BKFS) (41 items)	Food neophobia was negatively associated with vegetable consumption and dietary variety (assessed with the number of foods eaten)
Kähkönen <i>et al.</i> <sup>(30)</sup>	114	Children Age: 3–5 years 59.6 % female 40.4 % male	FNS* (10 items, 7-point scale)	FFQ for FV	Food neophobia was negatively correlated with cooked vegetable consumption
Koivisto-Hursti & Sjöden <sup>(155)</sup>	722	Children and their families Age: 7–17 years	FNS* (10 items, 5-point scale)	FFQ (20 food items)	FNS score was positively correlated with the number of foods never eaten both in children and parents

Table 3. (Continued)

Authors	Sample Size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Kozioł-Kozakowska <i>et al.</i> <sup>(8)</sup>	325	Children Age: 2-5-7 years 48.6 % girls 51.4 % boys	CFNSII (6 items, 4-point scale) ≤ 9: low 10-18: medium ≥ 19: high	FFQ 3-d dietary records (2 weekdays, 1 weekend)	Children with high levels of food neophobia had lower intake of eggs, legumes, and raw and cooked vegetables; children with higher levels of food neophobia consumed sweet and salty snacks more often than children with lower food neophobia levels Chocolate, sweets and salty snacks were eaten more often between meals while fruits were chosen less by children with higher food neophobia levels There was a negative correlation between food neophobia and vitamin C intake; highly neophobic children had a higher intake of energy and carbohydrates and lower intake of vitamin C and thiamine than less neophobic children The frequency of fast-food consumption did not differ according to the level of food neophobia
Kutbi <i>et al.</i> <sup>(26)</sup>	424	Children Age: 6-12 years 50.5 % girls 49.5 % boys	FNSII (10 items, 7-point scale) < 31.3: low 31.3-55.7: medium > 55.7: high	24-h dietary recall	Food neophobia was associated with a lower intake of protein, cholesterol and minerals (K, P, Mg, Fe, Zn and Se)
Maiz & Balluerka <sup>(22)</sup>	831	Children and adolescents Age: 8-16 years 55.7 % females 44.3 % males	CFNSII (8 items, 5-point scale) < 14.88: low (neophilic) 14.88-27.99: average > 27.99: high (neophobic)	Mediterranean Diet Quality Index (KIDMED) Quality of Mediterranean diet	More neophobic children had average KIDMED scores, while more neophobic adolescents demonstrated poorer KIDMED scores and more neophilic children and adolescents obtained good KIDMED scores Neophobics had a poorer quality of Mediterranean diet due to lower intake of FV, and fish and higher intake of sweets or candy Neophobics consumed less FV, fish and cereals or grains for breakfast than their neophilic peers did; neophobic children also ate more pasta/rice and sweets or candy than their neophilic peers did
Maslin <i>et al.</i> <sup>(119)</sup>	64	Children Age: 7-13 years 47.5 % female 52.5 % male	CFNS* (10 items, 7-point scale)	Food diary for 4 consecutive days	Food neophobia was not correlated with any macro- or micronutrient intake
Nicklaus <i>et al.</i> <sup>(158)</sup>	339	Children Baseline: 24-36 months Follow-up: 4-22 years	A neophobia questionnaire was adapted from 2 different scales (FNS and Food Attitude Survey)* (10 items, 7 of them from the FNS, 7-point scale)	The early variety-seeking score was calculated according to the number of different foods the child selected and the total number of different foods that were offered in the nursery lunch Follow-up: The food variety-seeking score was calculated according to the number of foods consumed from the list and the total number of foods	Food neophobia was inversely associated with both baseline and follow-up food variety-seeking scores
Perry <i>et al.</i> <sup>(112)</sup>	330	Infants Age: 24 months 54.2 % girls 45.8 % boys	CFNS* (6 items, 4-point scale)	24-h recall (collected via phone interviews) 2-d diet records (2 weekdays, 1 weekend)	Infants with higher food neophobia had a lower variety of vegetables and fruits in their diets Food neophobia was positively correlated with the percentage of total energy intake provided by foods with high energy and low nutrient density

Food neophobia and dietary behaviours

Table 3. (Continued)

Authors	Sample Size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Proserpio <i>et al.</i> <sup>(21)</sup>	529	Children Age: 9–12 years 54 % girls 46 % boys	Italian CFNS§ (8 items, 5-point scale) ≤ 17: low 18–23: medium ≥ 24: high	FFQ (17 food categories)	Food neophobia was negatively associated with the consumption of fresh FV, whole-grain biscuits, seeds and nuts, and pasta
Quick <i>et al.</i> <sup>(116)</sup>	252	Children and adolescents with type 1 diabetes Age: 8–18 years 48 % female 52 % male	Abbreviated CFNS* (4 items, 4-point scale)	3-d diet records (2 weekdays, 1 weekend) Dietary variety was assessed based on 20 food groups Healthy Eating Index-2005 Nutrient-Rich Foods Index 9.3 Whole Plant Food Density	Food neophobia was negatively correlated with dietary variety Food neophobia was negatively associated with the Healthy Eating Index-2005 and Nutrient-Rich Foods Index 9.3 Food neophobia was not associated with Whole Plant Food Density Food neophobia was negatively associated with K intake
Rodriguez-Tadeo <i>et al.</i> <sup>(23)</sup>	1491	Children and adolescents Age: 8–11 years and 12–18 years 49.5 % girls 50.5 % boys	FNSII (10 items, 7-point scale)	Mediterranean Diet Quality Index (KIDMED)	Neophobic adolescents had lower consumption of vegetables and breakfast cereals or derivatives, but they had higher consumption of candy and sweets compared with non-neophobic adolescents There was an inverse linear relationship between the degree of food neophobia and the quality of the diet There was no difference in other components of the Mediterranean diet according to the level of food neophobia
Roßbach <i>et al.</i> <sup>(118)</sup>	166	Children and adolescents Age: 10–18 years 51.2 % girls 48.8 % boys	FNS* (10 items, 7-point scale)	3-d weighed dietary records (3 consecutive days) Overall food variety score Core food variety score	Food neophobia was negatively related to the percentage of total energy intake from protein only among boys; it was not related to the percentage of total energy intake from other macronutrients or added sugars among either boys or girls Food neophobia was not associated with either the overall or core food variety score; however, there was a trend towards increasing food neophobia scores with decreasing core food variety scores among boys
Tsuji <i>et al.</i> <sup>(19)</sup>	323	Children Age: 4–6 years 48.3 % girls 51.7 % boys	CFNS† (6 items, 4-point scale) 7–14: low 15–17: middle 18–24: high	3-d diet records (2 weekdays, 1 weekend) Data on the intake of FV and soya foods were presented	Among boys, intake of vegetables and soya products was significantly higher in those with low neophobia scores; however, fruit intake was not related to food neophobia level Among girls, there was no significant relationship between food neophobia levels and vegetable, fruit or soya intake
Wardle <i>et al.</i> <sup>(105)</sup>	564	Children Age: 2–6 years 50 % female 47 % male 3 % not specified	CFNS* (6 items, 4-point scale)	The frequency of FV consumption by both parent and child was measured using single items: 'How often do (you/your child) eat the following items?'	Children's food neophobia negatively correlated with the frequency of FV consumption; there was a stronger negative correlation between neophobia and frequency of FV consumption for boys than for girls and this difference was largely due to a significantly stronger relationship between neophobia and vegetable consumption in boys than in girls

Table 3. (Continued)

Authors	Sample Size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Xi <i>et al.</i> <sup>(20)</sup>	747	Children Age: 12–36 months 43.4 % girls 56.6 % boys	CFNS§ (6 items, 7-point scale). ≤ 15: low 15–28: medium ≥ 28: high	Quantified FFQ (27 items) Dietary diversity score Vegetable variety score	Toddlers with high levels of food neophobia consumed vegetables (except legumes), fruits, beans and bean products, meat, poultry, fish and shrimp, and animal offal less frequently, whereas they consumed snacks and sugar-sweetened beverages more frequently than their peers Food neophobia among toddlers was not associated with the frequency of consumption of cereals, eggs, milk and dairy products Toddlers with high levels of food neophobia had lower dietary diversity and vegetable diversity scores than those with low levels of neophobia
Coulthard & Sealy <sup>(78)</sup>	62	Children Age: 3–4 years 56.4 % girls 43.6 % boys	CFNS* (6 items, 4-point scale)	4-d diet records Quantified FV frequency questionnaire	There were negative associations between food neophobia and daily FV portions consumed by children
Maiz <i>et al.</i> <sup>(81)</sup>	165	Children Age: 8–12 years 55.1 % female 44.9 % male	Spanish FNS* (10 items, 7-point scale)	Actual familiar and unfamiliar FV intake (pre- and post-weighing)	Food neophobia was negatively associated with the intake of almost all familiar and unfamiliar foods, except for the intake of spinach sponge cake
Marlow & Forestell <sup>(110)</sup>	148	Children Age: 6–10 years 44.7 % female 55.3 % male	CFNS* (6 items, 5-point scale)	Actual familiar and unfamiliar FV intake (pre- and post-weighing)	Food neophobia was negatively related to the consumption of both familiar and unfamiliar FV
Houston-Price <i>et al.</i> <sup>(111)</sup>	100	Children Age: 2 years 50 % female 50 % male	CFNS* (6 items, 5-point scale)	Child FFQ	Food neophobia was negatively associated with the number of tasted FV and mean consumption of FV
El Mouallem <i>et al.</i> <sup>(117)</sup>	656	Children Age: 2–10 years 50.8 % female 49.2 % male	FNS* (10 items, 7-point scale)	Questions about the refusal of certain types of food	Refusal to eat legumes, fish, fruits and eggs was significantly associated with higher FNS scores

FNS, Food Neophobia Scale; CFNS, Child Food Neophobia Scale; FSQ, Food Situations Questionnaire.

\* FNS score was used as a continuous variable.

† FNS scores were divided according to tertiles.

‡ It is not clear how the cut-off points of FNS score was determined.

§ Quartiles.

|| Mean ± sd.

Overall, the results indicate that children with a higher level of food neophobia need more support to eat core food groups and improve the quality of their diets.

Food neophobia has negatively associated with the dietary intake of adults as well (Table 4). Jaeger *et al.*<sup>(18)</sup> reported that food neophobia was negatively related to the consumption frequency of familiar foods in the daily diet as well as unfamiliar foods. Food neophobia has also been linked to the less frequent consumption of core foods such as FV<sup>(5,27,57,79,90,123–125)</sup> or fish<sup>(79,90,123)</sup>. Only one study reported contrary results, concluding that there were more people among food neophobics who often consumed fresh FV<sup>(13)</sup>. The findings on the relationships between food neophobia and the consumption of red meat<sup>(13,79,100)</sup> and milk and dairy products<sup>(5,13,123,126)</sup> have been contradictory. On the other hand, except for the study of Knaapila *et al.*<sup>(90)</sup>, most studies have reported food neophobia to be positively associated with the consumption of tasty but unhealthy foods and drinks<sup>(18,100,123,126)</sup>. Considering these food consumption habits, the results of studies reporting that food neophobia was positively related to the percentage of energy from free sugars<sup>(124)</sup> or that individuals with higher food neophobia scores had higher percentages of total energy intake from carbohydrates and saturated fat<sup>(9)</sup> are not surprising.

Among population-based studies, Sarin *et al.*<sup>(9)</sup> found that food neophobia was associated with lower diet quality as determined using the Baltic Sea Diet Score. A similar finding was reported in another study conducted with Finnish adults<sup>(27)</sup>. Hazley *et al.*<sup>(124)</sup> found that food neophobia was inversely associated with dietary variety but not with diet quality among Irish adults. Predieri *et al.*<sup>(123)</sup> revealed that food neophobia was negatively related to compliance with the Mediterranean diet. However, in a non-population-based study<sup>(127)</sup>, no significant relationship was found between food neophobia and adherence to a Mediterranean diet.

Although further studies conducted with different populations will provide a better understanding of the relationship between food neophobia and dietary intake among adults, the trends observed among children and adolescents indicate that dietary habits learned or acquired during childhood persist into adulthood. Consequently, it can be suggested that food neophobia is related to poor dietary behaviour throughout the lifespan and that the possible effects of food neophobia on diet are carried from early life into later life.

**The relationship between food neophobia and eating behaviours.** Food neophobia is often discussed together with picky eating. Picky eating is defined as the rejection of a substantial number of foods that may be familiar or unfamiliar. The concepts of food neophobia and picky eating are sometimes confused with each other. While there is a tendency to be selective about food in both cases, neophobia is characterised by the reluctance to eat new foods. However, for picky eaters, familiarity is not the issue. They may reject both familiar and unfamiliar foods. Picky eaters may also reject certain types of food textures, or they may consume inadequate amounts of food. Contrary to neophobics, who usually reject food before tasting it due to the underlying fear of novelty, picky eaters generally reject food after tasting. Although the discussion of whether these two

phenomena share a common etiological pathway is still ongoing<sup>(128)</sup>, all studies support the conclusion that these two forms of food rejection are highly correlated with each other<sup>(20,88,113,116,129,130)</sup>.

Apart from picky eating, food neophobia was positively associated with satiety responsiveness and emotional undereating among children<sup>(88)</sup>. In healthy young Swedish adults, it was negatively correlated with appetite<sup>(131)</sup>. These findings are logical, as food neophobia is generally positively correlated with a lack of interest in food<sup>(88)</sup>.

Eating occasions were also evaluated in some studies. Children who rarely ate at the dinner table with their families, often ate in their rooms and ate while playing games (tablet, PlayStation, etc.) were found to have higher levels of food neophobia compared with other children<sup>(117)</sup>. It has usually been indicated that there is a negative correlation between food neophobia and healthy eating habits<sup>(8,22)</sup>. Preschool children with high levels of food neophobia were found to consume fewer meals and more snacks between meals<sup>(8)</sup>, and neophobic adolescents skipped breakfast more often<sup>(22)</sup>.

Some studies<sup>(100,120)</sup> have shown that food neophobia is negatively associated with the consumption frequency of take-away foods and eating meals outside the home. That may be related to the fact that neophobic individuals avoid meals outside the home due to anxiety about new foods. The acceptance of school lunches was also negatively associated with food neophobia<sup>(132)</sup>. However, currently there is limited evidence regarding eating occasions and these findings need to be verified. Age, sex and cultural differences may also have interactions with the relationship between food neophobia and eating behaviour, which needs to be addressed in further studies.

### *Interventions aiming to reduce food neophobia*

Reducing food neophobia is critical to the development of healthy dietary behaviours, as food neophobia is a barrier to healthy eating. However, food neophobia does not appear to fade naturally with age<sup>(12,65)</sup>. Therefore, some interventions are necessary to reduce it. Although the trait of food neophobia is hard to change, intervention studies have shown that it could be reduced. The interventions applied in twelve of the seventeen relevant studies included in this review were successful in reducing food neophobia. These studies are reviewed here in terms of intervention-related characteristics, such as the type, frequency and duration of the intervention, and participant characteristics, such as age and baseline food neophobia.

Only eleven studies evaluated the effectiveness of the intervention using a control group<sup>(12,64,133–141)</sup>. Most of the interventions consisted of educational programmes such as taste<sup>(134,142)</sup>, sensory<sup>(12,64,135,136)</sup>, culinary<sup>(143)</sup> or nutrition<sup>(140,144)</sup> education/lessons. The objectives of the taste, sensory and culinary education programmes were to awaken curiosity and interest in foods, increase familiarity with and exposure to foods and create positive attitudes towards and experiences with foods. There were also significant decreases in the FNS scores of the children participating in these programmes<sup>(12,64,136,140,142,143)</sup>. A study<sup>(144)</sup> comparing cooking-related activities and nutrition education activities found that although both interventions reduced food



**Table 4.** Studies investigating the relationship between food neophobia and dietary intake in adults and the elderly

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Costa <i>et al.</i> <sup>(5)</sup>	223	Adults and the elderly Age: 18–84 years 59.6 % female 40.4 % male	FNS* (10 items, 7-point scale)	Semi-quantitative FFQ (86 items)	Individuals with higher food neophobia consumed less vegetables and fruits such as broccoli, turnip greens, tomatoes, onions, lettuce, tree nuts, cherries, and melon and the consumption of milk and codfish increased with increasing food neophobia There was no significant relationship between food neophobia and the daily intake of energy and macronutrients
Eertmans <i>et al.</i> <sup>(101)</sup>	324	Adults Age: 18.6 ± 2.5 years 85 % women 15 % men	FNS* (10 items, 7-point scale)	Semi-quantitative FFQ (60 food items)	Food neophobia was negatively associated with salty snack consumption
Hazley <i>et al.</i> <sup>(124)</sup>	1088	Adults and the elderly Age: 18–90 years 50.5 % female 49.5 % male	FNS* (10 items, 7-point scale)	Semi-weighted food diary (4 d) Total Dietary Variety Food-Group Variety FV Variety Mean Adequacy Ratio Nutrient-Rich Food Index	Food neophobia was inversely associated with dietary variety Food neophobia was not associated with diet quality Food neophobia showed a small significant inverse association with total FV intake Food neophobia was negatively associated with vitamin C and Mg Food neophobia was positively associated with the percentage of energy from free sugars Food neophobia was not significantly associated with other macro- and micronutrients
Jaeger <i>et al.</i> <sup>(18)</sup>	1167	Adults and the elderly Age: 18–72 years 59 % female 41 % male	FNS† (10 items, 7-point scale) 10–21: low 23–30: medium 31–68: high	24-h food intake recall (145 items)	Individuals with high levels of food neophobia consumed 32.4 % of all 145 food/beverage items less frequently Individuals with high levels of food neophobia consumed not only unfamiliar foods less frequently but also familiar foods such as tomatoes, greens, onions and cucumbers; individuals with high food neophobia had lower dietary diversity Individuals with high levels of neophobia consumed some foods such as milk chocolate and vanilla ice cream more frequently
Jeżewska-Zychowicz <i>et al.</i> <sup>(13)</sup>	1017	Adults Age: > 18 years 61.3 % female 38.7 % male	FNSII (10 items, 7-point scale) < 30.8: food neophobic 30.8–47.0: neutral > 47.0: food neophilic Higher FNS scores indicate higher food neophilia	Beliefs and Eating Habits Questionnaire (KomPAN)	Among the food neophobic, more people often consumed fresh vegetables, fruit and meat products (the upper tertiles) and more people who rarely consumed functional and convenience foods, sweets and sweetened beverages (the lower tertiles) There was no association between the level of food neophobia and milk, dairy product or cheese consumption
Knaapila <i>et al.</i> <sup>(90)</sup>	1175	Adults Age: 20–25 years 54.7 % women 45.3 % men	FNS* (10 items, 7-point scale)	Consumption frequency of 46 items (38 foods, 8 beverages)	Food neophobia was negatively correlated with the intake frequency of FV and fish, but it was not related to the consumption of sweet-fatty and salty-fatty foods among both women and men
Knaapila <i>et al.</i> <sup>(27)</sup>	2191	Adults Age: 18–57 years 53.8 % women 46.2 % men	FNS with minor modification (10 items, 7-point scale) 10–24: food neophilic 25–39: median group 40–70: food neophobic	Index of Diet Quality (18 items)	Food neophobia scores were negatively correlated with vegetable and fruit consumption and with diet quality among both women and men
Laaksonen <i>et al.</i> <sup>(57)</sup>	357	Adults and the elderly Age: 20–72 years 77 % female 23 % male	FNS† (10 items, 7-point scale) 10–19: low 20–31: medium < 32–68: high	Frequency of consumption of berries (14 items)	The most neophobic group gave lower ratings for 4 berries compared with less neophobic groups
Paupério <i>et al.</i> <sup>(125)</sup>	219	Pregnant women Gestation age: 36.62 ± 3.36 weeks	FNS* (10 items, 7-point scale)	Semi-quantitative FFQ (one global item for fruits and one for vegetables)	Pregnant women consuming at least 5 portions/d of FV scored higher for neophilic traits

Food neophobia and dietary behaviours

Table 4. (Continued)

Authors	Sample size (n)	Characteristics of the participants	Assessment of the food neophobia level	Assessment of dietary intake	Findings
Predieri <i>et al.</i> <sup>(123)</sup>	2416	Adults Age: 18–60 years 58.5 % women 41.5 % men	FNS‡ (10 items, 7-point scale) 10–18: low 19–35: medium 36–69: high	Food Familiarity Index (FFI) Italian Taste Mediterranean Index	Food neophobics consumed vegetables, legumes, fish, pasta, dairy and wine less frequently; however, these individuals consumed soft drinks and sweets more frequently An increase in food neophobia was related to a decrease in the frequency of intake of foods included in the Mediterranean diet; therefore, food neophobia negatively associated with compliance with the Mediterranean diet
Sarin <i>et al.</i> <sup>(9)</sup>	2982	Adults and the elderly Age: 25–74 years 54.4 % women 45.6 % men	FNS§ (10 items, 7-point scale) 10–24: food neophilic 25–39: median group 40–70: food neophobic	Baltic Sea Diet Score (BSDS) FFQ (131 food items)	Increased food neophobia was associated with reduced quality of diet in the DILGOM 2007 and DILGOM 2014 studies Individuals with higher food neophobia scores had a higher percentage of total energy intake from carbohydrates and saturated fat; they also had a lower percentage of total energy intake from proteins, MUFA and PUFA, and alcohol and salt
Siegrist <i>et al.</i> <sup>(79)</sup>	4436	Adults and the elderly Age: 21–99 years 52.8 % female 47.2 % male	FNS* (10 items, 7-point scale)	Short FFQ	Individuals with higher food neophobia scores consumed smaller amounts of vegetables, salad, fish and poultry; no relationship was detected between food neophobia and fruit, beef or veal, and sausage consumption
Spinelli <i>et al.</i> <sup>(69)</sup>	1146	Adults Age: 18–60 years 61 % female 39 % male	FNS* (10 items, 7-point scale)	Frequency of consumption of chili pepper and pungent food (6 items)	Non-users of chili pepper were more neophobic than regular users (consuming chili pepper and pungent foods at least 1–2 times per week) and occasional users (1–3 times per month); food neophobia was negatively associated with the yearly intake of hot chili pepper
Zickgraf & Schepps <sup>(126)</sup>	328	Adults Age: ≥ 18 years 50.5 % female 43.6 % male 2 people did not specify sex	FNS* (10 items, 7-point scale)	Self-reported number of servings consumed in a typical day across 9 categories	Food neophobia was negatively correlated with daily servings of FV and protein and water consumption Food neophobia was positively associated with starch, snacks, desserts and soda consumption Food neophobia was not associated with dairy consumption
Pliner & Hobden <sup>(2)</sup>	Sample 1: 39 Sample 2: 34	Adults Age: 18–74 years	FNS* (10 items, 7-point scale)	The frequency of eating some foods was assessed using a 7-point scale Sample 1: 30 food items: 15 unfamiliar – 15 familiar Sample 2: 10 food pairs: 5 unfamiliar – 5 familiar	Sample 1: More neophobic subjects reported having eaten fewer times the unfamiliar foods. However, FNS scores were not significantly correlated with the times eaten ratings for the familiar foods Sample 2: FNS scores were not correlated with times eaten the unfamiliar or familiar foods
Aiello <i>et al.</i> <sup>(127)</sup>	328	Adults Age: 18–35 years 58.3 % female 41.7 % male	FNS§ (10 items, 5-point scale) < 12: food neophilia 12–27: neutral ≥ 28: food neophobia	-Mediterranean diet score -Mediterranean score -Questionnaire to measure Mediterranean diet	No significant relationship was found between food neophobia and adherence to the Mediterranean diet
Yodogawa <i>et al.</i> <sup>(159)</sup>	238	Elderly Age: ≥ 65 years 71.8 % women 28.2 % men	FNS* (10 items, 7-point scale)	Mini Nutritional Assessment (MNA)	Older adults with higher food neophobia had higher risk of malnutrition
Jaeger <i>et al.</i> <sup>(100)</sup>	1676	Adults Age: 18–65 years 50 % women 50 % men	FNS* (10 items, 7-point scale)	Frequency of consumption was assessed using a 5-point scale (5 food items)	Food neophobia was negatively correlated with the consumption frequency of red meat and take-away foods, while it was positively correlated with the consumption frequency of tasty but unhealthy foods and drinks

\* FNS score was used as a continuous variable.

† FNS scores were divided according to tertiles.

‡ Quartiles.

§ FNS score was categorised based on the cut-off scores of another study.

|| Mean ± sd.



**Table 5.** Descriptions of intervention studies aiming to reduce food neophobia

Authors	Sample size (n)	Study design	Characteristics of the participants	Assessment of the food neophobia level	Intervention	Duration	Findings
Laureati <i>et al.</i> <sup>(133)</sup>	560: Experimental (n 374), Control (n 186)	Quasi-experimental design	Children Age: 6–9 years	CFNS* (8 items, 5-point facial scale) CFNS scores were assessed at baseline, after the intervention and 6 months later	The experimental group received the intervention (watched motivational videos, read letters to encourage them to eat FV and received a small reward for eating one portion of both a fruit and a vegetable) together with the provision of FV The control group received the FV only A portion of each FV was served raw and provided daily	16 d	Food neophobia remained stable over time for the control group, whereas a systematic, significant decrease was observed for the experimental group After the intervention, the experimental group had significantly lower scores than the control group, and the difference between the two groups was still significant after 6 months Younger children benefited slightly more from the intervention than older children
Bennett <i>et al.</i> <sup>(141)</sup>	61 Control (n 19) Mindful Breathing (n 20) Mindful Raisin-Eating (n 22)	Pretest–posttest design	Children Age: 10–12 years	FSQ* (10 items, 5-point scale)	Control group completed a 10-page book that consists of food-facts, food-quiz questions and FV shapes to be coloured in Mindful Breathing group listened to mp3 record related to mindful breathing exercise Mindful Raisin-Eating listened to an mp3 recording of a guided mindful raisin-eating exercise Each of the interventions lasted 5 min	5 d	Food neophobia remained stable over time for all groups There was not a statistically significant change in food neophobia among the control group or either intervention group
Mustonen & Tuorila <sup>(64)</sup>	164: Education (n 92), Control (n 72)	Quasi-experimental design	Children Age: 8 and 11 years	FNS* (10 items, 7-point scale)	The education groups received 10 sensory lessons; the control group received no lessons The two education groups were called E1 (one wave of education) and E2 (two waves of education) The first wave of sensory education comprised nine sensory lessons and a restaurant visit; the second wave of sensory education consisted of five extensive lessons	–	Sensory education decreased food neophobia and the effect was strongest in the group receiving both waves of education for both age groups Among younger children receiving only one education wave, food neophobia decreased and remained at the same level until the end of the study; the effect was not significant for the older group E2 differed from E1 significantly only for the younger age group
Ali <i>et al.</i> <sup>(143)</sup>	40	Pretest–posttest design	Children Age: 6–11 years	FNS† (10 items, 5-point scale) ≤ 17: low 18–24: medium ≥ 25: high	Culinary education classes were spread over one academic year and took place once a week, amounting to a total of 30 1-h classes The culinary education programme included 30 recipes	30 weeks	Food neophobia significantly decreased from 24.6 to 20.7 points; there were 20 children with high food neophobia before the intervention and 9 afterwards

Food neophobia and dietary behaviours

Table 5. (Continued)

Authors	Sample size (n)	Study design	Characteristics of the participants	Assessment of the food neophobia level	Intervention	Duration	Findings
Battjes-Fries <i>et al.</i> <sup>(134)</sup>	877: TL (n 236), TLVM (n 364), Control (n 277)	Quasi-experimental design	Children Age: 4–12 years	CFNS* (6 items, 5-point scale)	Taste Lessons (TL) consisted of five lessons per grade on the themes of taste development, healthy eating, food production, consumer skills and cooking; each lesson took on average 45 min and included group talks and in-class hands-on activities Taste Lessons Vegetable Menu (TLVM) consisted of the five above lessons and four additional hands-on activities	–	All study groups had slightly decreased FNS scores; this was significant only in the control group, but not significantly different from the TLVM and TL groups No significant intervention effects were found on food neophobia
Blomkvist <i>et al.</i> <sup>(135)</sup>	144: Diet (n 42), Diet + Sapere (n 63), Control (n 39)	Cluster-randomised controlled trial	Children Age: 1 year	CFNS* (6 items, 7-point scale)	The intervention was digitally administered via information and recipes on a study website Both intervention groups were served a warm lunch meal including three alternating intervention vegetables (3 d/week); children were exposed to each vegetable at least six times during the menu period Intervention group 2 (Diet + Sapere) also received pedagogical tools in weekly sensory lessons	3 months	There was not a statistically significant change in food neophobia among the control group or either intervention group
Maiz <i>et al.</i> <sup>(144)</sup>	202: NE (n 99), HO (n 103)	Quasi-experimental design	Children Age: 8–9 years	Spanish FNS* (8 items, 5-point scale)	Nutrition education (NE) and Hands-on (HO) groups participated in 3 workshops (1 h/week) HO group attended cooking-related activities: choosing a recipe, purchasing ingredients and cooking NE group participated in nutrition education activities: creating their food and a physical activity pyramid, learning the Spanish food pyramid, shaping a face using images of food	3 weeks	Both nutrition education and cooking-related activities reduced food neophobia, but only the reduction in the cooking-related activity group was statistically significant
Park & Cho <sup>(142)</sup>	101	Pretest–posttest design	Children Age: 7–9 years	Adapted FNS* (10 items, 7-point scale)	Children participated in 12 sessions of a taste education programme, which was held for 100 min for each session once a week	3 months	The taste education programme effectively reduced food neophobia
Reverdy <i>et al.</i> <sup>(136)</sup>	180: Experimental (n 90), Control (n 90)	Quasi-experimental design	Children Age: 8–10 years	Adapted French version of FNS* (10 items, 7-point scale), with evaluations at baseline, after the intervention and 10 months later	Children in the experimental group participated in a sensory education programme consisting of 12 lessons of 90 min each	4 months	Food neophobia decreased significantly in the experimental group, but these effects disappeared 10 months later Younger children in the experimental group seemed to benefit slightly (not significantly) more from the education programme than did the older children

Table 5. (Continued)

Authors	Sample size (n)	Study design	Characteristics of the participants	Assessment of the food neophobia level	Intervention	Duration	Findings
Skouw <i>et al.</i> <sup>(146)</sup>	12 families (n 39): Game (n 22), Non-game (n 17)	Pilot study	Children Age: 5–13 years	Danish version of FNS* (6 items, 7-point scale)	The board game was centred around a story of a chef who has forgotten to purchase FV for a dinner party at a castle; players would complete three different tasks present on the game board  Non-game families were provided with a representative selection of the three categories of tasks present on the board game, including tastings of FV	3 weeks	All groups showed a decrease in FNS scores from baseline to follow-up test, but significant reductions in FNS scores were only found for non-game children, non-game parents and game parents, not game children  The board game was not effective in significantly reducing children's food neophobia
Woo & Lee <sup>(12)</sup>	75: Educated (n 26), Control-1 (n 26), Control-2 (n 23)	Quasi-experimental design	Children Education Control-1: Age: 2nd and 3rd grades Control-2: Age: 6th grade	FNS* (10 items, 5-point scale)  Higher FNS scores reflected a high degree of acceptance of unfamiliar foods	The sensory education programme consisted of 12 lessons and the programme was divided into two sessions; during the first session, the children were trained to understand different ways to feel and express the taste of foods, and during the second session, children experienced food preferences and eating behaviours  Each lesson was designed to be 40 min/one lesson/week	12 weeks	Sensory education led to positive changes in the FNS scores; there were no changes in Control-1 and Control-2  Findings from Control-2 suggested that food neophobia may not naturally change as children grow older
Rigal <i>et al.</i> <sup>(137)</sup>	123: WRP (n 72), Control (n 51)	Quasi-experimental design	Adolescents Age: 10–17 years	French version of the FNS* (13 items, 4-point scale)	The residential weight reduction programme (WRP) combined a balanced diet, nutritional courses and daily physical activities; adolescents stayed for 6 months to 1 year and ate all their meals at the clinical centre during the week	8.9 ± 3.8 months	Food neophobia decreased with age both in the WRP and in the control group  FNS scores did not significantly differ between groups before and after the intervention
Monneuse <i>et al.</i> <sup>(149)</sup>	39	Pretest–posttest design	Adolescents Age: 10.5–17.5 years	French version of the FNS* (13 items, 4-point scale)	The WRP combined a balanced diet, nutritional courses and daily physical activities; adolescents stayed for 6 months to 1 year and ate all their meals at the clinical centre during the week	10.4 ± 4.4 months	Food neophobia was not significantly decreased after WRP; the decrease was correlated with an increase in mean food liking scores, a decrease in the number of food dislikes and an increase in liking FV
Kim & Park <sup>(145)</sup>	202	Pretest–posttest design	Children Age: 3rd and 6th grades	Korean version of the FNS* (10 items, 3-point scale)	Garden-based integrated programme consisted of 12 sessions and included gardening, nutritional education and cooking activities utilising	12 weeks	Garden-based intervention programme decreased the food neophobia of 3rd graders significantly, but there were no significant differences in the scores of 6th graders

Food neophobia and dietary behaviours

Table 5. (Continued)

Authors	Sample size (n)	Study design	Characteristics of the participants	Assessment of the food neophobia level	Intervention	Duration	Findings
Owen <i>et al.</i> <sup>(138)</sup>	127: Fruit book (n 42), Vegetable book (n 46), Control (n 39)	Randomised controlled trial	Children Age: 21–24 months	CFNS* (6 items, 4-point scale) CFNS was evaluated at baseline, after the intervention, and 3 months later	harvests. The programme was conducted 40 min/once a week Visual familiarisation phase: Parents and their children in the intervention group looked at the vegetable or fruit book for 5 min every day for 14 consecutive days Taste-exposure phase: Following the visual phase, parents in all three groups offered their children both target foods every day for 15 consecutive days	4 weeks	No change in food neophobia was seen in children in the intervention groups; the control group showed a trajectory of increasing food neophobia over time with a significant increase from baseline to follow-up, and looking at vegetable or fruit picture books disrupted the increases in food neophobia
Skouteris <i>et al.</i> <sup>(139)</sup>	201: Intervention (n 104), Control (n 97)	Randomised controlled trial	Parent–child dyads Age: 20–42 months	FNS* (10 items, 7-point scale) FNS was evaluated at baseline, after the intervention, and 6 and 12 months later	The intervention group participated in 90-min workshops related to nutrition, physical activity, and parenting and lifestyle behaviours including guided active play and healthy snack time This programme was delivered to parents and their children	10 weeks	Food neophobia was lower in the intervention group than in the control group immediately after the intervention and 12 months after the intervention
García-Muñoz <i>et al.</i> <sup>(140)</sup>	339: Experimental (n 190), Control (n 149)	Quasi-experimental design	Children Age: 9–14 years	Italian CFNS‡ (8-items, 5-point scale) ≤ 15: low 16–22: medium ≥ 23: high	The experimental group took part in five short lessons (9 posters and 5 short videos) about healthy habits, properties of food categories and food intake recommendations	4 weeks	FNS score was reduced by the intervention after a healthy eating education programme, especially among children with medium and high FNS scores; the reduction of the FNS was higher in the groups with higher FNS scores

\* FNS score was used as a continuous variable.

† It is not clear how the cut-off points of FNS score were determined.

‡ FNS scores were divided according to quartiles.

neophobia, cooking-related activities were more effective. Considering that 'familiarity' is a much more important motivation than 'health aspects of food' among the food choice motivations of neophobic individuals<sup>(68,94,99,101)</sup>, it is not surprising that experiential learning methods, such as cooking, gardening and tasting, are more promising for reducing food neophobia compared with nutrition education. While participating in gardening activities was effective in reducing the food neophobia of third-grade children<sup>(145)</sup>, playing a board game related to nutrients<sup>(146)</sup> and mindfulness exercises (mindful breathing and mindful raisin-eating)<sup>(141)</sup> were not found to be effective.

Besides the type of intervention, the intensity of the intervention, consisting of the number and duration of exposure sessions, is another important parameter. For example, a recent meta-analysis study of children<sup>(147)</sup> concluded that a minimum of 8–10 exposures are required to increase the consumption of new and undesirable vegetables. In the study of Mustonen and Tuorila<sup>(64)</sup>, the effect of a second wave of sensory education on reducing food neophobia was evaluated, and it was reported that the effect was strongest in the group receiving both waves of sensory education. In studies<sup>(134,135)</sup> in which the intervention reduced food neophobia, but the decrease was not statistically significant, one of the reasons may have been that these were low-intensity interventions.

Studies have evaluated the impact of single-component or multi-component interventions on food neophobia. Single-component interventions involve only one type of strategy, while multi-component interventions involve a combination of strategies. Only four studies<sup>(133,136,138,139)</sup> had a follow-up period, and in three of them<sup>(133,138,139)</sup>, the effect of the intervention on food neophobia was maintained in the long term. Although the difference in follow-up periods makes comparisons difficult, the effects of multi-component interventions on neophobia continued for a longer time<sup>(133,139)</sup>, while the effects of a single-component intervention disappeared 10 months after the intervention<sup>(136)</sup>. Owen *et al.*<sup>(138)</sup> found that visual familiarity with food before exposure reduced the increase in food neophobia with age, which was a very important contribution to the relevant literature.

The effects of interventions on food neophobia also varied according to the age of the participants. Food neophobia may be seen in all age groups, but it increases sharply in the weaning period and reaches its highest level at the ages of 2–6 years<sup>(93)</sup>. During this period of life, toddlers begin to categorise foods that are novel to them<sup>(128)</sup>. Toddlers' development of physical and motor skills also increases after the age of 2, so they may have access to a more varied diet after this age<sup>(148)</sup>. In the study of Owen *et al.*<sup>(138)</sup>, the reason why the intervention was not effective may have been related to the age of the children. Skouteris *et al.*<sup>(139)</sup> reported that multi-component workshop interventions significantly reduced food neophobia in children aged 20–42 months, and this effect was observed even after 1 year. Moreover, interventions aimed at reducing food neophobia were more effective for younger children<sup>(64,133,136,145)</sup>. These findings can be explained with the model proposed by Loewen and Pliner<sup>(50)</sup>, according to which the neophobic response after exposure to food stimuli differs depending on whether the child is younger or older than 9 years old. Since

children younger than 9 years have lower levels of optimal arousal, their willingness to taste novel foods is lower and their neophobic reactions are stronger. Therefore, the age of 9 years appears to be a critical period in a child's life with respect to the development of food behaviour. Another important parameter affecting the results of such interventions is the baseline level of food neophobia of the participants. Children with higher levels of food neophobia before education had higher decreases in FNS scores with intervention<sup>(140)</sup>.

In summary, food neophobia is not a stable personality trait. Food neophobia may be reduced with various interventions that increase exposure to and familiarity with foods. It can be thought that multi-component and repeated interventions, especially when they are started at an early age, may have high potential to reduce food neophobia.

## Discussion

The aims of this narrative review were to examine the relationship between food neophobia and dietary behaviours throughout the lifespan and to examine the impact of interventions on food neophobia. In this context, existing studies have identified the concept of food familiarity, food hedonics and food preferences, the motivations of food choice, dietary intake and eating behaviours.

Our most important finding was that food neophobia was associated with lower diet variety and poorer diet quality. Some of the factors related to the negative relationship between food neophobia and healthy diet behaviours were that individuals with higher food neophobia had lower familiarity and hedonics for many foods, gave more importance to familiarity in their food choices rather than health and nutrient content and consumed core foods, especially FV, less frequently and in lower amounts. Although differences in methods of determining food choice and dietary intake lead to variations between studies, studies have generally indicated that food neophobia is a barrier to healthy dietary behaviours.

Another finding of this review was that food neophobia is not a stable personality trait. Most studies showed that food neophobia could be reduced. However, the small number of intervention studies, the absence of a control group in some studies<sup>(143–146,149)</sup> and differences in the characteristics of participants and types and intensities of interventions make it difficult to compare such studies. There is a need for better planned randomised controlled trials comparing different interventions. In addition, all these intervention studies were conducted with children and adolescents. Therefore, it remains unclear whether similar interventions will be effective in reducing adults' food neophobia. Future research should be planned to answer this question.

In almost all studies included in this review, food neophobia was evaluated with the FNS, the Child FNS or modified/adapted versions of the FNS. The FNS is the only instrument with a validated behavioural test, and it is also the only scale whose items are balanced<sup>(150)</sup>. However, the FNS has some possible limitations. It is a very dated scale, having been developed in 1992. Over the years, many countries have become multicultural with



globalisation. As a result, certain expressions in FNS items 4 ('foods from different cultures'), 5 ('ethnic food'), and 10 ('ethnic restaurants') may not reflect food neophobia nowadays, especially in multicultural populations. Also, the 'dinner parties' expression in item 6 is difficult to understand across different cultures. In addition, the FNS was developed and validated in a specific population (Canadian psychology students). Therefore, its use in ethnically and culturally diverse multicultural populations is limited. However, de Kock *et al.*<sup>(151)</sup> very recently updated the original FNS by modifying culturally unfamiliar words and expressions and removing two items due to ambiguity (item 8) and cultural inappropriateness (item 10), producing an alternative FNS.

There are also differences in versions of the FNS and the evaluations of FNS scores. Studies have used distinct modifications and adaptations of the FNS that differ in language, rating scales or the number of items. This is a significant reason for the heterogeneity among studies. However, differences in the calculations of FNS scores (to create neophilic or neophobic scores) and in the categorisations of FNS scores (neophilic–neophobic or low–moderate–high food neophobia) have also been other reasons for heterogeneity among studies. Furthermore, in studies conducted with children and adolescents, some used the FNS as filled in by parents instead of children, while others used the Child FNS. Although there was a strong correlation between parent-reported child food neophobia and child self-reported food neophobia<sup>(152)</sup>, the way in which neophobia is assessed is important. For example, a recent systematic review<sup>(11)</sup> excluded studies in which parents assessed the food neophobia of their children.

There are several limitations to the present narrative review. The major limitation of this review was difficulties due to differences in the scales and methods used to assess food neophobia and dietary behaviours. This limitation highlights the need to use standard and valid tools to characterise food neophobia and dietary behaviours in the future. This review excluded reports in languages other than English, which could cause language bias. Additionally, most of the studies included in the present review were cross-sectional in design, so they did not provide any evidence about cause-and-effect relationships. Lastly, because the present work was a narrative review, the quality of each study was not assessed. This limits conclusive comparisons between studies.

### Conclusion

Overall, food neophobia is negatively correlated with hedonics and willingness to try novel and/or familiar foods and it is thus associated with lower dietary variety and poorer diet quality. Although it peaks during childhood and is generally evaluated as a problem of the childhood period, its relationship with diet variety and quality continues throughout life. Therefore, food neophobia may be a barrier to adequate and balanced dietary habits. However, food neophobia is not a stable personality trait. Many interventions including sensory, taste, culinary and nutrition education, and gardening activities that increase children's familiarity with foods can reduce food neophobia. Therefore, the inclusion of strategies that are effective in reducing food

neophobia in health policies aiming to increase diet quality may facilitate the achievement of these goals.

### Acknowledgements

The authors thank Yusuf Emuk, research assistant at Izmir Katip Celebi University, who provided advice for the present review.

This research received no specific grant from any funding agency or the commercial or not-for-profit sectors.

E. B. K. and Y. K. designed the study and conducted the literature search. Y. K. and E. B. K. drafted the manuscript. E. B. K. critically reviewed the manuscript. All authors read and approved the final manuscript. The authors have no conflicts of interest to disclose. The authors have no financial relationships relevant to this article to disclose.

The authors declare that they have no conflict of interest.

### References

1. Crane AL, Brown GE, Chivers DP, *et al.* (2019) An ecological framework of neophobia: from cells to organisms to populations. *Biol Rev* **95**, 218–231.
2. Pliner PH & Karen H (1992) Development of a scale to measure the trait of food neophobia in humans. *Appetite* **19**, 105–120.
3. Pliner P & Salvy SJ (2006) Food neophobia in humans. In *The Psychology of Food Choice*, 2nd ed., pp. 75–92 [R Shepherd & M Raats, editors]. CABI. Digital library. eISBN: 978-1-84593-086-8.
4. Raudenbush B & Capiola A (2012) Physiological responses of food neophobics and food neophilics to food and non-food stimuli. *Appetite* **58**, 1106–1108.
5. Costa A, Silva C & Oliveira A (2019) Food neophobia and its association with food preferences and dietary intake of adults. *Nutr Diet* **77**, 542–549.
6. Guzek D, Głabska D, Lange E, *et al.* (2017) A Polish study on the influence of food neophobia in children (10–12 years old) on the intake of vegetables and fruits. *Nutrients* **9**, 563.
7. Guzek D, Głabska D, Mellová B, *et al.* (2018) Influence of food neophobia level on fruit and vegetable intake and its association with urban area of residence and physical activity in a nationwide case-control study of Polish adolescents. *Nutrients* **10**, 897.
8. Koziół-Kozakowska A, Piórecka B & Schlegel-Zawadzka M (2017) Prevalence of food neophobia in pre-school children from southern Poland and its association with eating habits, dietary intake and anthropometric parameters: a cross-sectional study. *Public Health Nutr* **21**, 1106–1114.
9. Sarin HV, Taba N, Fischer K, *et al.* (2019) Food neophobia associates with poorer dietary quality, metabolic risk factors, and increased disease outcome risk in population-based cohorts in a metabolomics study. *Am J Clin Nutr* **110**, 233–245.
10. Capiola A & Raudenbush B (2012) The effects of food neophobia and foodophilia on diet and metabolic processing. *Food Nutr Sci* **3**, 1397–1403.
11. Rabadán A & Bernabéu R (2021) A systematic review of studies using the Food Neophobia Scale: conclusions from thirty years of studies. *Food Qual Prefer* **93**, 104241.
12. Woo T & Lee KH (2013) Effects of sensory education based on classroom activities for lower grade school children. *Nutr Res Pract* **7**, 336–341.

13. Jezewska-Zychowicz M, Plichta M, Drywień ME, *et al.* (2021) Food neophobia among adults: differences in dietary patterns, food choice motives, and food labels reading in Poles. *Nutrients* **13**, 1590.
14. Murray JM, Easton K & Best DJ (2001) A study of Chinese-origin and European-origin Australian consumers' texture preferences using a novel extruded product. *J Sens Stud* **16**, 485–504.
15. Gan K, Tithecott C, Neilson L, *et al.* (2021) Picky eating is associated with lower nutrient intakes from children's home-packed school lunches. *Nutrients* **13**, 1759.
16. Romaniw OC, Rajpal R, Duncan AM, *et al.* (2020) Nutrition in disguise: effects of food neophobia, healthy eating interests and provision of health information on liking and perceptions of nutrient-dense foods in older adults. *Foods* **10**, 60.
17. Bajec MR & Pickering GJ (2010) Association of thermal taste and PROP responsiveness with food liking, neophobia, body mass index, and waist circumference. *Food Qual Prefer* **21**, 589–601.
18. Jaeger SR, Rasmussen MA & Prescott J (2017) Relationships between food neophobia and food intake and preferences: findings from a sample of New Zealand adults. *Appetite* **116**, 410–422.
19. Tsuji M, Nakamura K, Tamai Y, *et al.* (2011) Relationship of intake of plant-based foods with 6-n-propylthiouracil sensitivity and food neophobia in Japanese preschool children. *Eur J Clin Nutr* **66**, 47–52.
20. Xi Y, Liu Y, Yang Q, *et al.* (2022) Food neophobia and its association with vegetable, fruit and snack intake among 12- to 36-month toddlers in China: a cross-sectional study. *Food Qual Prefer* **98**, 104513.
21. Proserpio C, Almlí VL, Sandvik P, *et al.* (2020) Cross-national differences in child food neophobia: a comparison of five European countries. *Food Qual Prefer* **81**, 103861.
22. Maiz E & Balluerka N (2016) Nutritional status and Mediterranean diet quality among Spanish children and adolescents with food neophobia. *Food Qual Prefer* **52**, 133–142.
23. Rodríguez-Tadeo A, Patiño-Villena B, González Martínez-La Cuesta E, *et al.* (2018) Food neophobia, Mediterranean diet adherence and acceptance of healthy foods prepared in gastronomic workshops by Spanish students. *Nutr Hosp* **35**, 642–649.
24. de Andrade Previato HDR & Behrens JH (2017) Taste-related factors and food neophobia: are they associated with nutritional status and teenagers' food choices? *Nutrition* **42**, 23–29.
25. Dos Anjos LA, Dos Santos Vieira DA, Freire Siqueira BN, *et al.* (2021) Low adherence to traditional dietary pattern and food preferences of low-income preschool children with food neophobia. *Public Health Nutr* **24**, 2859–2866.
26. Kutbi HA, Asiri RM, Alghamdi MA, *et al.* (2022) Food neophobia and its association with nutrient intake among Saudi children. *Food Qual Prefer* **96**, 104372.
27. Knaapila AJ, Sandell MA, Vaarno J, *et al.* (2014) Food neophobia associates with lower dietary quality and higher BMI in Finnish adults. *Public Health Nutr* **18**, 2161–2171.
28. Falciglia GA, Couch SC, Gribble LS, *et al.* (2000) Food Neophobia in childhood affects dietary variety. *J Am Diet Assoc* **100**, 1474–1481.
29. Pliner P (1994) Development of measures of food neophobia in children. *Appetite* **23**, 147–163.
30. Kähkönen K, Hujo M, Sandell M, *et al.* (2020) Fruit and vegetable consumption among 3–5-year-old Finnish children and their parents: is there an association? *Food Qual Prefer* **82**, 103886.
31. Johnson SL, Davies PL, Boles RE, *et al.* (2015) Young children's food neophobia characteristics and sensory behaviors are related to their food intake. *J Nutr* **145**, 2610–2616.
32. Loewen R & Pliner P (2000) The Food Situations Questionnaire: a measure of children's willingness to try novel foods in stimulating and non-stimulating situations. *Appetite* **35**, 239–250.
33. Mielby L, Nørgaard M, Edelenbos M, *et al.* (2012) Adolescents' affective response toward fruit and vegetable snacks. *J Sens Stud* **27**, 425–438.
34. Marijn Stok F, Renner B, Allan J, *et al.* (2018) Dietary behavior: an interdisciplinary conceptual analysis and taxonomy. *Front Psychol* **9**, 1689.
35. Chen PJ & Antonelli M (2020) Conceptual models of food choice: influential factors related to foods, individual differences, and society. *Foods* **9**, 1898.
36. Aldridge V, Dovey TM & Halford JCG (2009) The role of familiarity in dietary development. *Dev Rev* **29**, 32–44.
37. Russell CG & Worsley A (2008) A population-based study of preschoolers' food neophobia and its associations with food preferences. *J Nutr Educ Behav* **40**, 11–19.
38. Gomes AI, Barros L, Pereira AI, *et al.* (2018) Assessing children's willingness to try new foods: validation of a Portuguese version of the child's food neophobia scale for parents of young children. *Food Qual Prefer* **63**, 151–158.
39. Kähkönen K, Sandell M, Rönkä A, *et al.* (2021) Children's fruit and vegetable preferences are associated with their mothers' and fathers' preferences. *Foods* **10**, 261.
40. Çınar Ç, Wesseldijk LW, Karinen AK, *et al.* (2022) Sex differences in the genetic and environmental underpinnings of meat and plant preferences. *Food Qual Prefer* **98**, 104421.
41. Skinner JD, Carruth BR, Wendy B, *et al.* (2002) Children's food preferences: a longitudinal analysis. *J Am Diet Assoc* **102**, 1638–1647.
42. Kaar JL, Shapiro ALB, Fell DM, *et al.* (2016) Parental feeding practices, food neophobia, and child food preferences: what combination of factors results in children eating a variety of foods? *Food Qual Prefer* **50**, 57–64.
43. Cooke L (2007) The importance of exposure for healthy eating in childhood: a review. *J Hum Nutr Diet* **20**, 294–301.
44. Stratton LM, Vella MN, Sheeshka J, *et al.* (2015) Food neophobia is related to factors associated with functional food consumption in older adults. *Food Qual Prefer* **41**, 133–140.
45. Olabi A, Najm NEO, Baghdadi OK, *et al.* (2009) Food neophobia levels of Lebanese and American college students. *Food Qual Prefer* **20**, 353–362.
46. Dibbets P, Borger L & Nederkoorn C (2021) Filthy fruit! Confirmation bias and novel food. *Appetite* **167**, 105607.
47. Fenko A, Backhaus BW & van Hoof JJ (2015) The influence of product- and person-related factors on consumer hedonic responses to soy products. *Food Qual Prefer* **41**, 30–40.
48. Raudenbush B & Frank RA (1999) Assessing food neophobia: the role of stimulus familiarity. *Appetite* **32**, 261–271.
49. Laureati M, Spinelli S, Monteleone E, *et al.* (2018) Associations between food neophobia and responsiveness to 'warning' chemosensory sensations in food products in a large population sample. *Food Qual Prefer* **68**, 113–124.
50. Loewen R & Pliner P (1999) Effects of prior exposure to palatable and unpalatable novel foods on children's willingness to taste other novel foods. *Appetite* **32**, 351–366.
51. Choe JY & Cho MS (2011) Food neophobia and willingness to try non-traditional foods for Koreans. *Food Qual Prefer* **22**, 671–677.
52. Hwang J & Lin TN (2010) Effects of food neophobia, familiarity, and nutrition information on consumer acceptance of

- Asian menu items. *J Hospitality Marketing Manage* **19**, 171–187.
53. Knaapila A, Laaksonen O, Virtanen M, *et al.* (2017) Pleasantness, familiarity, and identification of spice odors are interrelated and enhanced by consumption of herbs and food neophilia. *Appetite* **109**, 190–200.
  54. Martins Y, Marcia LP & Pliner P (1997) 'Try it, it's good and it's good for you': effects of taste and nutrition information on willingness to try novel foods. *Appetite* **28**, 89–102.
  55. Tuorila H, Lähteenmäki L, Pohjalainen L, *et al.* (2001) Food neophobia among the Finns and related responses to familiar and unfamiliar foods. *Food Qual Prefer* **12**, 29–37.
  56. De Toffoli A, Spinelli S, Monteleone E, *et al.* (2019) Influences of psychological traits and PROP taster status on familiarity with and choice of phenol-rich foods and beverages. *Nutrients* **11**, 1329.
  57. Laaksonen O, Knaapila A, Niva T, *et al.* (2016) Sensory properties and consumer characteristics contributing to liking of berries. *Food Qual Prefer* **53**, 117–126.
  58. Olabi A, Neuhaus T, Bustos R, *et al.* (2015) An investigation of flavor complexity and food neophobia. *Food Qual Prefer* **42**, 123–129.
  59. Brown SD (2012) Rejection of known and previously accepted foods during early childhood: an extension of the neophobic response? *Int J Child Health Nutr* **1**, 72–81.
  60. Wetherill MS, Williams MB, Reese J, *et al.* (2021) Methods for assessing willingness to try and vegetable consumption among children in indigenous early childcare settings: the FRESH study. *Nutrients* **14**, 58.
  61. Soucier VD, Doma KM, Farrell EL, *et al.* (2019) An examination of food neophobia in older adults. *Food Qual Prefer* **72**, 143–146.
  62. Flight I, Leppard P & Cox DN (2003) Food neophobia and associations with cultural diversity and socio-economic status amongst rural and urban Australian adolescents. *Appetite* **41**, 51–59.
  63. Raudenbush B, Schroth F, Reilley S, *et al.* (1998) Food neophobia, odor evaluation and exploratory sniffing behavior. *Appetite* **31**, 171–183.
  64. Mustonen S & Tuorila H (2010) Sensory education decreases food neophobia score and encourages trying unfamiliar foods in 8–12-year-old children. *Food Qual Prefer* **21**, 353–360.
  65. Moding KJ & Stifter CA (2016) Stability of food neophobia from infancy through early childhood. *Appetite* **97**, 72–78.
  66. Mascarello G, Pinto A, Rizzoli V, *et al.* (2020) Ethnic food consumption in Italy: the role of food neophobia and openness to different cultures. *Foods* **9**, 112.
  67. Guzek D, Nguyen D & Głabska D (2021) Food neophobia and consumer choices within Vietnamese menu in a Polish cohort study. *Int J Environ Res Public Health* **18**, 2925.
  68. Labrecque J, Doyon M, Bellavance F, *et al.* (2006) Acceptance of functional foods: a comparison of French, American, and French Canadian consumers. *Can J Agr Econ/Revue canadienne d'agroeconomie* **54**, 647–661.
  69. Spinelli S, De Toffoli A, Dinnella C, *et al.* (2018) Personality traits and gender influence liking and choice of food pungency. *Food Qual Prefer* **66**, 113–126.
  70. Törnwall O, Silventoinen K, Hiekkalinna T, *et al.* (2014) Identifying flavor preference subgroups. Genetic basis and related eating behavior traits. *Appetite* **75**, 1–10.
  71. Howard AJ, Mallan KM, Byrne R, *et al.* (2012) Toddlers' food preferences. The impact of novel food exposure, maternal preferences and food neophobia. *Appetite* **59**, 818–825.
  72. Schickenberg B, van Assema P, Brug J, *et al.* (2007) Are the Dutch acquainted with and willing to try healthful food products? The role of food neophobia. *Public Health Nutr* **11**, 493–500.
  73. Jaeger SR, Chheang SL & Prescott J (2021) Variations in the strength of association between food neophobia and food and beverage acceptability: a data-driven exploratory study of an arousal hypothesis. *Nutrients* **13**, 3657.
  74. Tuorila H, Meiselman HL, Bell R, *et al.* (1994) Role of sensory and cognitive information in the enhancement of certainty and liking for novel and familiar foods. *Appetite* **23**, 231–246.
  75. Fernandez C, DeJesus JM, Miller AL, *et al.* (2018) Selective eating behaviors in children: an observational validation of parental report measures. *Appetite* **127**, 163–170.
  76. Skinner J, Ruth Carruth B, Moran J, *et al.* (1998) Toddlers' food preferences: concordance with family members' preferences. *J Nutr Educ* **30**, 17–22.
  77. Appleton K, Dinnella C, Spinelli S, *et al.* (2019) Liking and consumption of vegetables with more appealing and less appealing sensory properties: associations with attitudes, food neophobia and food choice motivations in European adolescents. *Food Qual Prefer* **75**, 179–186.
  78. Coulthard H & Sealy A (2017) Play with your food! Sensory play is associated with tasting of fruits and vegetables in pre-school children. *Appetite* **113**, 84–90.
  79. Siegrist M, Hartmann C & Keller C (2013) Antecedents of food neophobia and its association with eating behavior and food choices. *Food Qual Prefer* **30**, 293–298.
  80. Laureati M, Bertoli S, Bergamaschi V, *et al.* (2015) Food neophobia and liking for fruits and vegetables are not related to Italian children's overweight. *Food Qual Prefer* **40**, 125–131.
  81. Maiz E, Urkia I, Bereciartu A, *et al.* (2019) Introducing novel fruits and vegetables: effects of involving children in artistic plating of food. *Food Qual Prefer* **77**, 172–183.
  82. Sharafi M, Duffy VB, Miller RJ, *et al.* (2016) Dietary behaviors of adults born prematurely may explain future risk for cardiovascular disease. *Appetite* **99**, 157–167.
  83. Monteleone E, Spinelli S, Dinnella C, *et al.* (2017) Exploring influences on food choice in a large population sample: the Italian Taste project. *Food Qual Prefer* **59**, 123–140.
  84. Agovi H, Pierguidi L, Dinnella C, *et al.* (2022) Attentional bias for vegetables is negatively associated with acceptability and is related to sensory properties. *Food Qual Prefer* **96**, 104429.
  85. Januszewska R, Viaene J, *et al.* (2012) Sensory evaluation of traditional products by variety-seekers and food neophobics. *J Culinary Sci Technol* **10**, 192–210.
  86. Mattes RD (1994) Influences on acceptance of bitter foods and beverages. *Physiol Behavior* **56**, 1229–1236.
  87. El Dine AN & Olabi A (2009) Effect of reference foods in repeated acceptability tests: testing familiar and novel foods using 2 acceptability scales. *J Food Sci* **74**, 97–106.
  88. Silva TA, Jordani MT, Guimaraes IG, *et al.* (2021) Assessment of eating behavior and food neophobia in children and adolescents from UBERABA-MG. *Rev Paul Pediatr* **39**, e2019368.
  89. Kähkönen K, Rönkä A, Hujo M, *et al.* (2018) Sensory-based food education in early childhood education and care, willingness to choose and eat fruit and vegetables, and the moderating role of maternal education and food neophobia. *Public Health Nutr* **21**, 2443–2453.
  90. Knaapila A, Silventoinen K, Broms U, *et al.* (2010) Food neophobia in young adults: genetic architecture and relation to personality, pleasantness and use frequency of foods, and body mass index- a twin study. *Behav Genet* **41**, 512–521.
  91. Sharafi M, Duffy VB, Miller RJ, *et al.* (2016) Dietary behaviors of adults born prematurely may explain future risk for cardiovascular disease. *Appetite* **99**, 157–167.





92. Forestell CA (2017) Flavor perception and preference development in human infants. *Ann Nutr Metab* **70**, 17–25.
93. Dovey TM, Staples PA, Gibson EL, *et al.* (2008) Food neophobia and 'picky/fussy' eating in children: a review. *Appetite* **50**, 181–193.
94. Guzek D, Peška J & Głąbska D (2019) Role of food neophobia and allergen content in food choices for a Polish cohort of young women. *Nutrients* **11**, 2622.
95. Guzek D & Głąbska D (2022) Food neophobia, familiarity with French cuisine, body mass, and restaurant food choices in a sample of Polish women. *Nutrients* **14**, 1502.
96. Appiani M, Rabitti NS, Methven L, *et al.* (2020) Assessment of lingual tactile sensitivity in children and adults: methodological suitability and challenges. *Foods* **9**, 1594.
97. Cappellotto M & Olsen A (2021) Food texture acceptance, sensory sensitivity, and food neophobia in children and their parents. *Foods* **10**, 2327.
98. Huang L, Bai L, Zhang X, *et al.* (2019) Re-understanding the antecedents of functional foods purchase: mediating effect of purchase attitude and moderating effect of food neophobia. *Food Qual Prefer* **73**, 266–275.
99. Jaeger SR, Roigard CM, Hunter DC, *et al.* (2021) Importance of food choice motives vary with degree of food neophobia. *Appetite* **159**, 105056.
100. Jaeger SR, Prescott J & Worch T (2022) Food neophobia modulates importance of food choice motives: replication, extension, and behavioural validation. *Food Qual Prefer* **97**, 104439.
101. Eertmans A, Victoir A, Vansant G, *et al.* (2005) Food-related personality traits, food choice motives and food intake: mediator and moderator relationships. *Food Qual Prefer* **16**, 714–726.
102. Rutishauser IH (2005) Dietary intake measurements. *Public Health Nutr* **8**, 1100–1107.
103. Shim J-S, Oh K & Kim HC (2014) Dietary assessment methods in epidemiologic studies. *Epidemiol Health* **36**, e2014009.
104. Helland SH, Bere E, Bjørnara HB, *et al.* (2017) Food neophobia and its association with intake of fish and other selected foods in a Norwegian sample of toddlers: a cross-sectional study. *Appetite* **114**, 110–117.
105. Wardle J, Carnell S & Cooke L (2005) Parental control over feeding and children's fruit and vegetable intake: how are they related? *J Am Diet Assoc* **105**, 227–232.
106. Cooke LJ, Wardle J, Gibson E, *et al.* (2004) Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutr* **7**, 295–302.
107. Coulthard H & Thakker D (2015) Enjoyment of tactile play is associated with lower food neophobia in preschool children. *J Acad Nutr Diet* **115**, 1134–1140.
108. Cooke L, Carnell S & Wardle J (2006) Food neophobia and mealtime food consumption in 4–5 year old children. *Int J Behav Nutr Phys Act* **3**, 14.
109. Coulthard H & Blissett J (2009) Fruit and vegetable consumption in children and their mothers. Moderating effects of child sensory sensitivity. *Appetite* **52**, 410–415.
110. Marlow CS & Forestell CA (2022) The effect of parental food neophobia on children's fruit and vegetable consumption: a serial mediation model. *Appetite* **172**, 105942.
111. Houston-Price C, Owen LH, Kennedy OB, *et al.* (2019) Parents' experiences of introducing toddlers to fruits and vegetables through repeated exposure, with and without prior visual familiarization to foods: evidence from daily diaries. *Food Qual Prefer* **71**, 291–300.
112. Perry RA, Mallan KM, Koo J, *et al.* (2015) Food neophobia and its association with diet quality and weight in children aged 24 months: a cross sectional study. *Int J Behav Nutr Phys Act* **12**, 13.
113. Galloway AT, Lee Y & Birch LL (2003) Predictors and consequences of food neophobia and pickiness in young girls. *J Am Diet Assoc* **103**, 692–698.
114. de Wild VW, Jager G, Olsen A, *et al.* (2018) Breast-feeding duration and child eating characteristics in relation to later vegetable intake in 2–6-year-old children in ten studies throughout Europe. *Public Health Nutr* **21**, 2320–2328.
115. Çınar Ç, Karinen AK & Tybur JM (2021) The multidimensional nature of food neophobia. *Appetite* **162**, 105177.
116. Quick V, Lipsky LM, Laffel LMB, *et al.* (2013) Relationships of neophobia and pickiness with dietary variety, dietary quality and diabetes management adherence in youth with type 1 diabetes. *Eur J Clin Nutr* **68**, 131–136.
117. El Mouallem R, Malaeb D, Akel M, *et al.* (2021) Food neophobia in Lebanese children: scale validation and correlates. *Public Health Nutr* **24**, 5015–5023.
118. Roßbach S, Foterek K, Schmidt I, *et al.* (2016) Food neophobia in German adolescents: determinants and association with dietary habits. *Appetite* **101**, 184–191.
119. Maslin K, Grimshaw K, Oliver E, *et al.* (2016) Taste preference, food neophobia and nutritional intake in children consuming a cows' milk exclusion diet: a prospective study. *J Hum Nutr Diet* **29**, 786–796.
120. Chitra U, Adhikari K, Radhika MS, *et al.* (2015) Neophobic tendencies and dietary behavior in a cohort of female college students from Southern India. *J Sens Stud* **31**, 70–77.
121. Bell LK, Jansen E, Mallan K, *et al.* (2018) Poor dietary patterns at 1–5 years of age are related to food neophobia and breastfeeding duration but not age of introduction to solids in a relatively advantaged sample. *Eat Behav* **31**, 28–34.
122. Jarman M, Ogden J, Inskip H, *et al.* (2015) How do mothers manage their preschool children's eating habits and does this change as children grow older? A longitudinal analysis. *Appetite* **95**, 466–474.
123. Predieri S, Sinesio F, Monteleone E, *et al.* (2020) Gender, age, geographical area, food neophobia and their relationships with the adherence to the Mediterranean diet: new insights from a large population cross-sectional study. *Nutrients* **12**, 1778.
124. Hazley D, McCarthy SN, Stack M, *et al.* (2022) Food neophobia and its relationship with dietary variety and quality in Irish adults: findings from a national cross-sectional study. *Appetite* **169**, 105859.
125. Paupério A, Severo M, Lopes C, *et al.* (2014) Could the Food Neophobia Scale be adapted to pregnant women? A confirmatory factor analysis in a Portuguese sample. *Appetite* **75**, 110–116.
126. Zickgraf HF & Schepps K (2016) Fruit and vegetable intake and dietary variety in adult picky eaters. *Food Qual Prefer* **54**, 39–50.
127. Aiello P, Peluso I & Villaño Valencia D (2022) Alcohol consumption by Italian and Spanish university students in relation to adherence to the Mediterranean diet and to the food neophobia: a pilot study. *Healthcare* **10**, 393.
128. Lafraire J, Rioux C, Giboreau A, *et al.* (2016) Food rejections in children: cognitive and social/environmental factors involved in food neophobia and picky/fussy eating behavior. *Appetite* **96**, 347–357.
129. Elkins A & Zickgraf HF (2018) Picky eating and food neophobia: resemblance and agreement in parent/young adult dyads. *Appetite* **126**, 36–42.
130. Zickgraf HF, Franklin ME & Rozin P (2016) Adult picky eaters with symptoms of avoidant/restrictive food intake disorder: comparable distress and comorbidity but different eating

- behaviors compared to those with disordered eating symptoms. *J Eat Disord* **4**, 26.
131. Nordin S, Broman DA, Garvill J, *et al.* (2004) Gender differences in factors affecting rejection of food in healthy young Swedish adults. *Appetite* **43**, 295–301.
  132. Tuorila H, Palmujoki I, Kytö E, *et al.* (2015) School meal acceptance depends on the dish, student, and context. *Food Qual Prefer* **46**, 126–136.
  133. Laureati M, Bergamaschi V & Pagliarini E (2014) School-based intervention with children. Peer-modeling, reward and repeated exposure reduce food neophobia and increase liking of fruits and vegetables. *Appetite* **83**, 26–32.
  134. Battjes-Fries MCE, Haveman-Nies A, Zeinstra GG, *et al.* (2017) Effectiveness of taste lessons with and without additional experiential learning activities on children's willingness to taste vegetables. *Appetite* **109**, 201–208.
  135. Blomkvist EAM, Wills AK, Helland SH, *et al.* (2021) Effectiveness of a kindergarten-based intervention to increase vegetable intake and reduce food neophobia amongst 1-year-old children: a cluster randomised controlled trial. *Food Nutr Res* **65**, 7679.
  136. Reverdy C, Chesnel F, Schlich P, *et al.* (2008) Effect of sensory education on willingness to taste novel food in children. *Appetite* **51**, 156–165.
  137. Rigal N, Frelut ML, Monneuse MO, *et al.* (2006) Food neophobia in the context of a varied diet induced by a weight reduction program in massively obese adolescents. *Appetite* **46**, 207–214.
  138. Owen LH, Kennedy OB, Hill C, *et al.* (2018) Peas, please! Food familiarization through picture books helps parents introduce vegetables into preschoolers' diets. *Appetite* **128**, 32–43.
  139. Skouteris H, Hill B, McCabe M, *et al.* (2015) A parent-based intervention to promote healthy eating and active behaviours in pre-school children: evaluation of the MEND 2–4 randomised controlled trial. *Pediatr Obes* **11**, 4–10.
  140. García-Muñoz S, Barlińska J, Wojtkowska K, *et al.* (2022) Is it possible to improve healthy food habits in schoolchildren? A cross cultural study among Spain and Poland. *Food Qual Prefer* **99**, 104534.
  141. Bennett C, Copello A, Jones C, *et al.* (2020) Children overcoming picky eating (COPE)- A cluster randomised controlled trial. *Appetite* **154**, 104791.
  142. Park BK & Cho MS (2016) Taste education reduces food neophobia and increases willingness to try novel foods in school children. *Nutr Res Pract* **10**, 221–228.
  143. Al Ali N, Arriaga A & Rubio M (2020) The cognitive and behavioral impact of a culinary education program on schoolchildren. *Nutr Food Sci* **51**, 10–29.
  144. Maiz E, Urkia-Susin I, Urdaneta E, *et al.* (2021) Child involvement in choosing a recipe, purchasing ingredients, and cooking at school increases willingness to try new foods and reduces food neophobia. *J Nutr Educ Behav* **53**, 279–289.
  145. Kim SO & Park SA (2020) Garden-based integrated intervention for improving children's eating behavior for vegetables. *Int J Environ Res Public Health* **17**, 1257.
  146. Skouw S, Suldrup A & Olsen A (2012) A Serious game approach to improve food behavior in families—a pilot study. *Nutrients* **12**, 1415.
  147. Evans CE, Christian MS, Cleghorn CL, *et al.* (2012) Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 years. *Am J Clin Nutr* **96**, 889–901.
  148. Demattè ML, Endrizzi I, Biasioli F, *et al.* (2013) Food neophobia and its relation with olfactory ability in common odour identification. *Appetite* **68**, 112–117.
  149. Monneuse MO, Rigal N, Frelut ML, *et al.* (2008) Taste acuity of obese adolescents and changes in food neophobia and food preferences during a weight reduction session. *Appetite* **50**, 302–307.
  150. Damsbo-Svendsen M, Frøst MB & Olsen A (2017) A review of instruments developed to measure food neophobia. *Appetite* **113**, 358–367.
  151. De Kock HL, Nkhabutlane P, Kobue-Lekalake RI, *et al.* (2022) An alternative food neophobia scale (FNS-A) to quantify responses to new foods. *Food Qual Prefer* **101**, 104626.
  152. Ayoughi F, Handley M, Garza J, *et al.* (2022) Parental perspective and feeding practices effects on food neophobia in elementary school children in San Luis Obispo County. *J Sens Stud* **37**, e12717.
  153. Donadini G, Spigno G & Porretta S (2021) Preschooler liking of meal components: the impact of familiarity, neophobia, and sensory characteristics. *J Sens Stud* **36**, e12649.
  154. Pliner P & Loewen ER (1997) Temperament and food neophobia in children and their mothers. *Appetite* **28**, 239–254.
  155. Hursti UKK & Po S (1997) Food and general neophobia and their relationship with self-reported food choice: familial resemblance in Swedish families with children of ages 7–17 years. *Appetite* **29**, 89–103.
  156. Potts HWW & Wardle J (1998) The list heuristic for studying personality correlates of food choice behaviour: a review and results from two samples. *Appetite* **30**, 79–92.
  157. Schickenberg B, van Assema P, Brug J, *et al.* (2011) Information about the taste stimulates choice of unfamiliar healthful food products. *J Hum Nutr Diet* **24**, 603–611.
  158. Nicklaus S, Boggio V, Chabanet C, *et al.* (2005) A prospective study of food variety seeking in childhood, adolescence and early adult life. *Appetite* **44**, 289–297.
  159. Yodogawa T, Nerome Y, Tokunaga J, *et al.* (2022) Effects of food neophobia and oral health on the nutritional status of community-dwelling older adults. *BMC geriatrics* **22**, 334.