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Programmes to manage food selectivity in individuals with autism spectrum disorder

Chiara Breda[1], Sara Santero[1], Maria Vittoria Conti[1]* and Hellas Cena[1,2]
[1]*Laboratory of Dietetics and Clinical Nutrition, Department of Public Health, Experimental and Forensic Medicine, University of Pavia, via Bassi 21, Pavia, Italy*
[2]*Clinical Nutrition and Dietetics Service, Unit of Internal Medicine and Endocrinology, ICS Maugeri IRCCS, University of Pavia, Pavia, Italy*

Abstract

Autism spectrum disorder (ASD) is a complex group of neurodevelopmental disorders characterised by impaired social communication and restricted interests/repetitive behaviours. In this regard, sensory processing difficulties and delayed oral motor skills often predispose individuals with ASD to food selectivity (FS). It is usually associated with repetitive eating patterns that can lead to multiple malnutrition conditions. The objective of this narrative review is to present an overview about the existing nutritional interventions aiming at promoting a healthy eating pattern and addressing food selectivity among individuals with ASD. Regarding the interventions targeting nutrition education, the majority of the analysed studies failed to demonstrate their effectiveness. On the other hand, many educational interventions involving taste or cooking sessions, as well as behavioural interventions for FS, demonstrated effective results. Moreover, multidisciplinary in tailoring such programmes, including psychology speech therapy and nutritional skills, is acknowledged as a key approach.

Key words: **Nutrition education: Autism spectrum disorder: Parent-training: Selective eating: Healthy behaviour: Caregiver: Parent-delivered education: Parental treatment: Food training: Feeding problems**

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Autism spectrum disorder and food selectivity: impact on the health status across the lifespan

Autism spectrum disorder (ASD) is a complex group of neurodevelopmental disorders such as autism, Asperger's syndrome (AS) and pervasive developmental disorder not otherwise specified (PDD-NOS)[1]. The most up-to-date diagnostic criteria of ASD[2] focuses on two core areas: (i) social communication impairment and (ii) restricted interests/repetitive behaviours[1].

Sensory processing difficulties, which encompass an increased or diminished sensitivity to the environmental sensory stimuli, also constitute another typical clinical feature[3]. Furthermore, a delay in the development of the oral motor skills is associated with ASD and may cause food refusal due to the textures that are difficult to chew or swallow[4,5]. The core sign of restrictive and repetitive behaviour, differences in sensory perception and delayed oral motor skills may contribute to feeding difficulties, resulting in food selectivity (FS)[4].

Bandini *et al.* (2010) introduced the first and only currently available classification of FS, analysing three domains (Table 1): (i) food refusal, (ii) limited food repertoire and (iii) high frequency of single food intake[6].

Delving into details, FS is commonly referred to as picky/fussy eating, characterised by a limited food repertoire in which the individual will experience food aversions related to specific texture, temperature, flavour, colour and odour[7]. In addition, individuals with ASD prefer 'predictable' foods also known as 'sameness', such as foods from specific brands, not only because of the taste but mainly because they are easily recognisable due to the packaging, thus being familiar[3,7].

Evidence shows that FS is often characterised by high consumption of energy-dense ultra-processed foods poor in nutrients, causing a significant reduction in the dietary diversity and increasing the risk to develop micronutrient deficiencies[3,7–9]. Nowadays scientific evidence indicates an increased risk of vitamin D deficiency among children and adolescents diagnosed with autism[10] as well as zinc, magnesium and calcium deficiencies[11,12].

Along with behavioural disturbances, several conditions coexist with individuals with ASD, such as gastrointestinal (GI) symptoms[7] which are four times more prevalent in children and adults with ASD compared with the neuro-typical population[13,14].

In addition to the previously mentioned state, the prevalence of obesity and overweight is increasing among individuals with

* **Corresponding author:** Maria Vittoria Conti, email: mariavittoria.conti@unipv.it
Chiara Breda and Sara Santero contributed equally.

Table 1. Schematic representation of Bandini's classification of FS[6]

Domain	Definition	Source of data
Food refusal	Number of food items the child refuse to eat Percentage of food items the child refuse to eat from those offered	Modified FFQ
Limited food repertoire	Number of unique food items consumed over a 3-d period	3-d food diary
High frequency single food intake	Single food item eaten 4–5 or more times daily	Modified FFQ

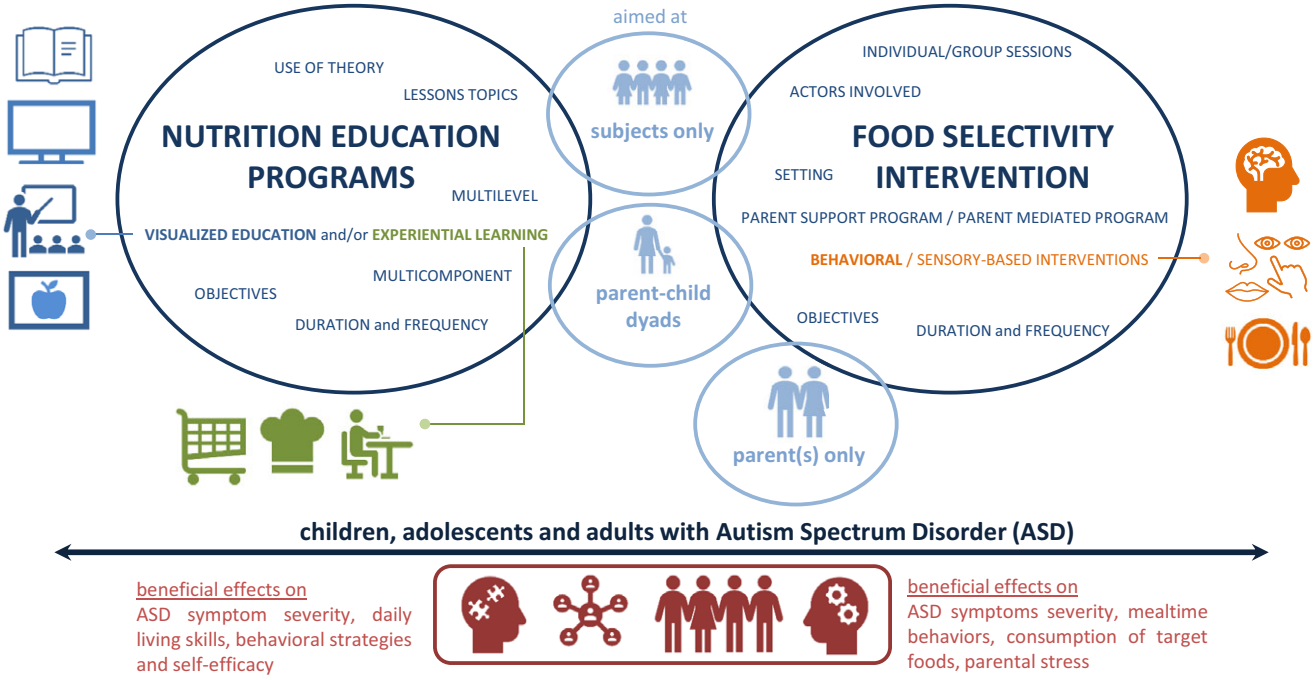

Fig. 1. Overview of the existing dietary interventions aimed at reducing FS and promoting healthy eating in individuals with ASD.

ASD[15]: the worldwide prevalence of obesity and overweight in individuals with ASD are 21·8 % and 19·8 %, respectively[16], and this condition could worsen their already vulnerable condition[17,18].

This alarming evidence mandates the creation of nutritional interventions specifically tailored for these individuals. The aim of the paper is to present an overview of the existing dietary interventions aimed at reducing FS and promoting healthy eating in individuals with ASD (Fig. 1).

Interventions addressing food selectivity

Due to the high prevalence of FS in individuals with ASD, many specialists attempted to develop dietary intervention programmes to counteract FS[19]. For this purpose, three main types of interventions were described in the literature: (i) behavioural interventions, (ii) sensory-based interventions and (iii) food chaining.

1. Behavioural interventions are currently supported by the strongest scientific evidence, and multiple studies link them to significant improvements in feeding behaviour and food consumption[20–26]. These evidence-based practices involve strategies such as functional assessment, positive, differential or non-contingent reinforcement, and escape extinction[27].
2. Sensory-based interventions are important since individuals with ASD are very sensitive to sensory factors, e.g. taste, texture or appearance of foods, leading to food rejection, gagging and vomiting[27]. Moreover, systematic desensitisation is commonly used as a treatment therapy for feeding difficulties, yet it is rarely documented in the literature. It is an internally driven 'bottom-up' approach that involves exposure to a feared stimulus (i.e. food) while engaging in relaxation or play activities[20,28].
3. Food chaining incorporates behavioural and sensory aspects of feeding, aiming at familiarising individuals with ASD with new foods that share similarities in taste, temperature or texture to the ones they already like and accept[29]. These food similarities are used to create 'food chains' or links between the foods that are considered acceptable to the child and the new ones. Based on this approach, anxiety level will be contained, enabling children to become more familiar with the new foods that will be included in their diet later on[30–32].

Other crucial considerations in managing FS include, firstly, the often-compromised oral motor skills in these individuals,

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which commonly contribute to the rejection of specific foods. Secondly, changes in the physical environment, such as seating arrangements, dish types and family food preferences, which could potentially impact children's eating behaviours; this influence may manifest through modelling the consumption of fruits and vegetables, controlling snack intake and eating a wide variety of foods[4,27,28].

It is evident that the various factors contributing to feeding difficulties require targeted interventions to be performed by different specialised professionals.

Another factor in classifying FS intervention programmes is related to the involvement of relatives/caregivers[33,34].

Bearss *et al.* (2015) classified the parent-training programmes for children with ASD as follows: parent support programmes (PSPs) and parent-mediated programmes (PMPs). PSPs supply parents with information and knowledge about ASD, while PMPs can be categorized as primary and complementary; in the former, caregivers facilitate the treatment from the outset, whereas in the latter, the therapist initially leads the treatment and involves the caregiver afterwards[31–34].

Parent training for FS has several advantages: it extends the intervention beyond the clinical setting, it is cost-effective since it requires less frequent clinical contact, and it has the potential to enhance the effect made during therapy[35,36].

In addition, greater improvements in generalisation and maintenance have been observed in cases where parents also served as therapy facilitators, and a slight tendency for improved feeding skills were observed in children whose parents received training as therapists[20,36].

The importance of parent training also resides in the fact that parents' behaviours can contribute to the development and persistence of feeding disorders: several studies have confirmed that family behaviour generally supports the functional development of feeding in children. Nevertheless, parent–child interactions might unintentionally enforce dietary restrictions on children or contribute to limited exposure to a variety of foods[26,28]

Moreover, parental stress can be greater in families of children with ASD, which, in itself, may lead to more behavioural changes in the child that negatively influence food selectivity[29]. Behavioural parent training (BPT) programmes, aimed at equipping caregivers with effective skills for managing their children's needs, have been shown to significantly increase caregivers self-efficacy and reduce their stress levels[23,24,36]. It is also important to note that conducting BPTs in a group setting can improve treatment availability, accessibility and engagement, and can provide a platform for caregivers to learn from one another and share common challenges[24].

Materials and methods

This narrative review started with literature research in February 2023, adopting a non-systematic approach. Studies were identified from PubMed, including only English-language manuscripts published from 2014 to 2024. Study protocols, pilot studies and randomised clinical trials (RCTs) were included. Moreover, the authors reported the following keywords: nutrition education, autism spectrum disorder, parent-training, selective eating, treatment, food selectivity, program, healthy behavior, weight management, cooking, taste education, eating, feeding, caregiver, parent-delivered education, parental treatment, plan, food training, training, feeding problems.

The scientific articles were primarily selected on the basis of title/abstract screening, and then screened by full text reading. A total of 202 articles were screened by title/abstract reading, and 121 studies were excluded, while four articles were excluded by full text reading. In total, seventy-seven articles were included. The articles were excluded on the basis of the following criteria: (i) they did not address the nutritional aspect neither from a nutritional knowledge perspective nor through practical tasting sessions; (ii) they did not focus on improving the dysfunctional behaviours associated with mealtimes; (iii) they utilized other study designs.

Results

The total number of studies included in the narrative review was twenty-nine, among which fourteen were based on nutritional education programmes and fifteen on dietary interventions addressing FS. The authors summarised the results in two different tables. The first table presents the papers focusing only on nutritional education programmes (Table 2)[37–54] and the second one those on dietary interventions addressing FS in individuals with ASD (Table 3)[20–24,27,35,36,55–57].

Nutrition education programmes

Nutrition education is defined as 'any set of learning experiences that are intended to facilitate the voluntary adoption of eating and other nutrition-related behaviors that are beneficial to their health and wellbeing'[58,59]. In fact, a properly designed nutrition education programme has the potential to enhance the preference for consuming different foods and to facilitate the implementation of appropriate dietary practices[60].

Nutrition education programmes can be classified on the basis of the presence of visual aids (visualised education, VE) and/or practical hands-on activities (experiential learning, EL)[60–65]. Furthermore, appropriate duration (≥6 months) and frequency (weekly or biweekly) of the programmes are defined, accompanied by long-term follow-up for the maintenance of healthy habits and lasting engagement[59,60,66–69]. The programme features should be multicomponent (i.e. involving several professionals), multilevel (i.e. involving several techniques/activities) and tailored to suit the age range of the participants[60]. Moreover, the programme should be guided by the application of behavioural change strategies (i.e. social cognitive theory or theory of planned behaviour or transtheoretical model of behaviour change)[59,60]. These reported characteristics were used to evaluate the nutrition education programmes included in this narrative review.

Considering the study analysed (Table 2), the majority of the programmes were tested as pilot studies (twelve out of fourteen)[37–45,47,50,53]. In most of the cases, nutrition education programmes were applied in the USA (twelve out of

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Table 2. Table summarising the education programmes targeting individuals with ASD

	Study design	Area	Duration and frequency of the program	Sample characteristics	Programme objectives	Topics treated	Use of theory	Multi component	Multilevel	VE*/ EL†
Shurack R. H. *et al.* 2022[37]	Pilot study	USA	4 weekly online sessions, 60 min each	10 adolescents (15–19 years old) Weight assessed	To assist adolescents in making healthy food choices to improve dietary patterns, and to teach food preparation safety measures	Shopping Healthily, Utilising the USDA MyPlate Mobile Application, Inexpensive Healthy Foods & Recipes	✗	✓	✗	VE EL
Garcia J. M. *et al.* 2021[38]	Pilot study	USA	16 twice a week sessions, 60 min each	10 adolescents (15–17 years old) Weight not assessed	To increase nutrition knowledge and self-efficacy on the basis of the CBPR approach	USDA MyPlate, food groups, nutrient versus caloric density, portion versus serving size, micronutrients, reading nutrition labels, grocery shopping, healthy snack and culinary demonstrations relevant to the topics of nutrition education	✓	✓	✓	VE EL
Garcia J. M. *et al.* 2023[39]	Pilot study	USA	24 twice a week sessions, 45 min each	13 young adults with ASD (22–31 years old) Weight not assessed	To increase nutrition knowledge and self-efficacy (meal preparation and culinary skills)	USDA MyPlate, food groups, nutrient versus caloric density, portion versus serving size, nutrition labels, grocery shopping, healthy choices when eating out, meal preparation, nutrition culinary tutorials	✓	✓	✓	VE EL
Veneruso M. *et al.* 2022[40]	Longitudinal pilot study	Italy	Not specified	20 adolescents and young adults (15–25 years old) Weight not assessed	To promote adaptive behaviour and social skills, and to reduce the severity of symptomatology through a culinary curriculum aimed to learn to make fresh pasta by hand	Skills and procedures required to complete fresh pasta	✗	✓	✗	VE EL
Goldschmidt J. *et al.* 2017[41]	Protocol for a pilot study	USA	50 twice-a-week sessions	13 young adults (20–25 years old) Weight not assessed	To promote generalised skills and as much independence as possible within the kitchen environment for adults with autism, to promote healthy eating habits and to increase portion control for unhealthy foods	Culinary lessons with emphasis on technique (e.g. chopping, grating, shredding), colour, texture, overall participant independence, safety, choice, meal planning	✓	✗	✓	EL
Gray H. L. *et al.*, 2022[42]	Protocol for a pilot RCT study (programme versus enhanced usual care)	USA	10 weekly sessions, 25 min each, plus 2 monthly booster sessions, 25 min each (delivered individually), plus 1 follow-up after 5 months	48 parent–child dyads (age birth to 36 months) Weight assessed	To prevent the development of feeding disorders and the long-term negative health impacts associated with poor dietary intake	Sensory properties of foods, introducing new foods, balanced eating and nutrition, beverages, mealtime routines and schedules, restructuring food environment	✓	✓	✓	VE EL

Table 2. (*Continued*)

	Study design	Area	Duration and frequency of the program	Sample characteristics	Programme objectives	Topics treated	Use of theory	Multi component	Multilevel	VE*/ EL†
Kuschner E. S. *et al.* 2017[43]	Pilot study	USA	14 weekly sessions, 90 min each, plus 2 follow-up sessions: after 1 month and after 3 months	11 children (8–11 years old) with their parents Weight not assessed	To help children develop skills to cope with anxiety, and to think and act flexibly with new or non-preferred foods, therefore increasing the food repertoire	Emphasise psychoeducation and provide training in cognitive behavioural strategies, combined with exposure-based methods commonly used in feeding treatments and with parent training	✗	✓	✓	VE EL
Burrell T. L. *et al.* 2020[44]	Pilot RCT study (programme versus structured parent education programme)	USA	12 sessions over 4 months, 60 min each, less than weekly, plus 1 follow-up after 1 month	10 children (5–12 years old) Weight assessed	To promote the US Department of Agriculture's MyPlate guidelines for well-balanced nutrition, providing nutrition and behaviour management strategies to children with ASD	Nutrition education, calorie reduction (e.g. diluting sweetened beverages, grazing reduction, increasing fruit and vegetable intake, and reducing portions), physical activity and behaviour management strategies	✗	✓	✓	VE
Buro A. W. *et al.* 2022[45,46]	Pilot study	USA	8 weekly online sessions, 30–45 mib each	27 adolescents (12–21 years old) Weight assessed	To address ASD-specific challenges, including sensory differences and cognitive rigidity, and to promote positive dietary behaviour change	Exploring taste, flavour, and texture, mealtimes and rules, and increasing their knowledge about food groups and nutrients, beverages, cooking, healthy eating habits and wellbeing	✓	**not specified**	✓	VE EL
Thorsteinsdottir S. *et al.* 2021, 2022 and 2023[47–49]	Longitudinal RCT pilot study (immediate intervention versus delayed intervention)	Iceland	1 week pre-intervention 2 seminars about parenting-education components, 2 h each, parents only. Then 7 weekly sessions with 6 kitchen lessons, 90 min each, for parent–child dyads	81 children, including 33 with ASD or ADHD and 48 neurotypical, (8–12 years old) and their parents Weight assessed; body composition assessed through bioimpedance analysis	To decrease fussy eating, and to both improve food variety and problematic behaviours in the long term	Parent–child games, interactive activities, sensory evaluation, food preparation skills, baking and cooking. All activities were based on food, using a multisensory approach incorporating sight, sound, touch, smell and taste	✗	✓	✓	VE EL
Ketcheson L. R. *et al.*, 2021[50]	Protocol for a pilot study	USA	Weekly online sessions over 12 months	180 individuals, including children and caregivers will be enrolled (2–18 years old) Weight will be assessed	To promote positive trajectories of health for children with ASD and their primary caregivers intervening on both nutrition and physical activity	Family nutrition education, USDA RDA recommendations, healthy snack and meal habits, and food preparation (recipe of the week)	✓	✓	✓	VE EL

Table 2. (*Continued*)

	Study design	Area	Duration and frequency of the program	Sample characteristics	Programme objectives	Topics treated	Use of theory	Multi component	Multilevel	VE*/ EL†
Espinoza J. C. *et al.* 2017 and 2021[51,52]	A secondary analysis of a RCT (families treated with comprehensive behavioural family-based lifestyle intervention, CBFLI, versus usual care)	USA	7 weekly sessions, approximately 2 h each. The programme was cycled multiple times	158 families, including 15 families with at least 1 child with ASD per family (7–18 years old) Weight assessed	To increase physical activity, nutrition knowledge and healthy eating habits both in children with ASD and their parents	Healthy Weight, Healthy Habits, Basics of Healthy Eating, Portions, Snacks, and Fast Foods, Meal Planning and Preparation, Physical Activity and Screen Time, Cooking, Shopping, and Eating Together	✓	✓	✓	VE EL
Manzanarez B. *et al.* 2021[53]	Pilot study	USA	6 weekly sessions, approximately 120 min each	50 individuals, including children with ASD (7–12 years old) and their parents Weight assessed	To address the needs of families of children with ASD and their unique challenges in managing their child's dietary needs, mealtime behaviours and weight status	Family-centred nutrition education (food groups, portions, fats and real versus processed food, sugar and hydration, healthy shopping, holidays and celebrations)	✓	✓	✓	VE EL
Kral T. V. E. *et al.* 2023[54]	RCT	USA	Daily for 3 months through an innovative mobile health (mHealth) nutrition intervention	38 parent–child dyads, including children aged 6–10 years old Weight assessed	To teach children about healthy eating and to motivate them to make healthy food choices in their daily lives To train parents in behaviour change strategies	Health benefits of fruits and vegetables versus undesirable properties of sugary drinks and salty and sugary snacks, Nutritional goals and targeted foods and beverages, explanation of 'Go' and 'Whoa' foods. Goal setting and selecting a reward	✗	✓	✓	VE EL

Legend: The programmes shown in the table are colour coded: in green are programmes aimed only at individuals with ASD, and in blue are those aimed at dyads (individual with ASD and his or her parents/caregivers). The selected cross-comparison criteria are the following: study type, sample characteristics, location, duration and frequency of the programme sessions, programme objectives, lessons topics, use of theory to develop the programme, multicomponent, multilevel, visualised education (VE) and/or experiential learning (EL). Sample characteristics: identifies the number of study participants, age and whether a weight assessment was conducted. Location: the country in which the programme was conducted. Duration and frequency: identifies the number of sessions held and the frequency with which they were conducted (e.g. weekly, biweekly . . .). Programme objectives: identifies the goals that the programme sets out to achieve. Lesson topics: the main thematics addressed during the sessions. Use of theory: the construction of the nutrition education programme based on a validated model for behaviour change. Multicomponent: the inclusion of several professional figures and parents to reach the educational aims. Multilevel: the inclusion of several techniques/activities. Visualised education (VE): the application of multimedia techniques to present education information in visual forms. Experiential learning (EL): the incorporation of hands-on activities.

* VE, visualised education.

† EL, experiential learning.

fourteen)[37–39,41–45,50–54], which aligned with the high prevalence of ASD in the American population[68].

In terms of age range, interventions focusing solely on individuals with ASD targeted adolescents (15–19 years old)[37,39] and/or young adults (20–31 years old)[38,40,41]. On the other hand, interventions targeting both those with ASD and their respective families, predominantly enrolled children (5–12 years old)[43,44,47,54]. Only nine out of fourteen programmes assessed the weight of the study participants[37,42,44,45,47,50,51,53,54].

In terms of duration, the programmes consisted of 4–25 weeks of intervention provided weekly once or twice; each session lasted from 25 to 120 min.

The main objective of all nutrition education programmes, whether stated implicitly or explicitly, was to prevent the adverse health effects caused by malnutrition condition. Delving into the evaluations of the covered topics, they included (i) fundamentals of nutrition, such as instructions on balanced nutrition (i.e. caloric reduction, macro- and micronutrient, portion versus serving size, food groups and beverages, USDA MyPlate), (ii) healthy grocery shopping and (iii) proper label reading. Moreover, specific nutritional aspects about the most frequently experienced feeding difficulties by individuals with ASD were also covered, including sensory properties of food and tasting sessions, meal planning (i.e. visual mealtime routines and schedules), food environment restructuring and behaviour management strategies (i.e. cognitive behaviour techniques). Classes (in person or online) were frequently combined with hands-on workshops (i.e. cooking demonstrations, healthy foods and snack tasting sessions) and some homework to promote the integration of the knowledge gained through the practices in their daily habits at home, and to ensure its long-term maintenance. The knowledge transition promotion was highlighted by the fact that twelve out of fourteen nutrition education programmes aimed at individuals with ASD involved visualised education and experiential learning activities[37–40,42,43,45,47,50,51,53,54].

In terms of the use of theory for behavioural change, only eight out of fourteen programmes reported clearly the use of at least one theory that underlined the construction of the nutrition education program[38,39,41,42,44,50,51,53].

Noteworthy was the use of a multidisciplinary approach, ensuring the involvement of multiple professionals (multicomponent), and the combination of multiple activities (multilevel). Indeed, ten out of fourteen programmes combined the two aspects[38,39,42–44,47,50,51,53,54].

In terms of results, almost half of the programmes focused mainly on the evaluation of the feasibility and acceptability of the programme[37–39,43–46], while three others focused on the description of the programme[41,42,50], without analysing the outcomes. In terms of domain behaviour, in the culinary programme developed by Veneruso *et al.* the severity of ASD symptoms and the daily living skills significantly improved[40]. They were assessed respectively using Childhood Autism Rating Scale, Second Edition (CARS-2) and Vineland Adaptive Behavior Scale II (VABS II) Daily Living Skills Scale[40].

In the programme developed by Buro *et al.*[45], an improvement in individuals' behavioural strategies and self-efficacy was detected using two scales from validated SCT-based surveys[70]. In terms of dietary intake, the programme developed by Buro and colleagues was effective in reducing the consumption of added sugar[45]; this was measured using the Block Kids 2004 food frequency questionnaire[45]. However, no post-intervention improvements were detected in the consumption of fruits and vegetables[47]. The taste education programme of Thorsteinsdottir and colleagues confirmed that there were no statistically significant results concerning the acceptance of fruits, despite the increased odds of accepting vegetables, nuts and seeds[47,48]. However, in this study, children's acceptance was assessed through parent-reported intake of selected food items[47,48]. Moreover, the programme showed a positive effect when compared with a waiting group, on all measures of Meals in Our Household Questionnaire. These effects remain stable through the 6 months follow-up period[47,48].

The mobile health intervention provided by Kral *et al.*[54] did not yield significant differences in terms of changes in the consumption of the targeted foods or beverages between the two groups. Only children who consumed few fruits and vegetables at baseline and who were highly engaged with the technology increased their intake post-intervention[54].

Furthermore, the comprehensive behavioural family-based lifestyle intervention (CBFLI) programme conducted by Espinoza and colleagues showed a significant decrease in BMI *Z*-scores in children with ASD as in NT children without specific adaptations for the ASD population[52]. However, the generalisability of this result is limited by the specific study sample characteristics: low-income, Hispanic/Latino, Spanish-speaking families[52].

In detail, the specific characteristics of the nutrition education programmes that were customised for individuals with ASDs are reported in Table 4.

Programmes to counteract food selectivity

Analysing the programmes addressing FS (Table 3), it was observed that most of them were presented in RCT pilot studies (six out of fifteen)[21,23,24,36,55,56], followed by RCTs (four out of fifteen)[20,56]. All studies were conducted in the USA, with the exception of Marshal J. *et al.* (2015), which was conducted in Australia[20]. The sample size of the studies was small: no study surpasses the participant count of forty-four participants.

Since all the analysed programmes were addressing children (maximum age 13 years), most of them (thirteen out of fifteen)[20,21,23,24,27,35,36,55–57] involved caregivers and were divided into PMPs (ten out of thirteen)[20,21,23,24,27,36,55–57] and PSPs (three out of thirteen)[24,35,56]. Parental involvement was absent in only two programmes[22]. Regarding the intervention setting of PMPs, six studies out of ten[21,23,24,27,36,57] were carried out in home setting, three out of ten[20,55] in clinical setting, and one out of ten[56] at home and in clinical settings.

Regarding the type of intervention of PMPs, the majority of studies considered were behavioural, two out of ten[27,55] employed different strategies (behavioural, sensory-based strategies and communication support) and just one[56] was sensory-based only.

As for PSPs, two out of three[24,56] were psychoeducational and supportive programmes, while one out of three[35] aimed for parental education about the typical sensory integration

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Table 3. Table summarising programmes targeting food selectivity in individuals with ASD

	Study design	Area and setting	Duration and frequency	Sample characteristics	Programme objectives	Type of intervention	Individual/ group sessions	Actors involved	PSP*/PMP†
Marshall J. *et al.* 2015[20] (a)	RCT	Australia (clinical setting)	10 weekly or intensive sessions, 30–60 min each plus 1 follow-up sessions after 3 months	44 children (2–6 years old) Weight assessed	Expanding dietary variety and volume and reducing challenging behaviours	Behavioural intervention	Individual sessions	Speech and language pathologist Parent educator Caregiver	PMP
Marshall J. *et al.* 2015[20] (b)	RCT	Australia (clinical setting)	10 weekly or intensive sessions, 30–60 min each plus 1 follow-up session after 3 months	34 children (2–6 years old) Weight assessed	Expanding dietary variety and interaction with food	Sensory-based intervention	Individual sessions	Speech and language pathologist Parent educator Caregiver	PMP
Johnson C. R. *et al.* 2015[21]	Open pilot trial	USA (home)	9 sessions over 16 weeks, 60–90 min each	Parents of 14 children (2–7 years old) Weight assessed	Reducing challenging child's behaviours and caregiver stress and expanding dietary variety	Behavioural intervention	Individual sessions	Therapist certified in Behaviour Analysis Caregiver	PMP
Peterson K. M. *et al.* 2016[22] (a)	Prospective study	USA (clinical setting)	9–16 sessions 3 times a week, 1·5 h each	3 children (4–6 years old) Weight not assessed	Expanding dietary variety and reducing challenging behaviours	Behavioural intervention	Individual sessions	ABA therapist	Caregivers not involved
Peterson K. M. *et al.* 2016[22] (b)	Prospective study	USA (indoor playground equipped with play materials and feeding rooms, 4 m by 4 m, in a clinic)	15–19 sessions 3 times a week, 1·5 h each	3 children (4–6 years old) Weight not assessed	Expanding dietary variety and reducing challenging behaviours	Sensory-based intervention	Individual sessions	Doctoral student in applied behaviour analysis (ABA) who completed 3-d basic and 2-d advanced training on sequential oral sensory approach (SOS)	Caregivers not involved
Johnson C. R. *et al.* 2019[23]	Pilot RCT	USA (home)	7 weekly sessions plus 4 sessions every other week, 60–90 min each, plus up to 3 parent coaching appointments via VSEE	42 children (2–11 years old) Weight not assessed	Reducing challenging child's behaviours and caregiver stress	Behavioural intervention	Individual sessions	Psychologists or behaviour analysts Dietitian Caregiver	PMP
Rohacek A. *et al.* 2023[24] (a)	Pilot RCT	USA (home)	6 weekly sessions, 120 min each, plus 1 follow-up session after 6 months	29 parents of children with ASD (5–9 years) Weight not assessed	Reducing child's challenging behaviours, caregiver stress, and improving caregiver mental health functioning	Behavioural intervention	Group sessions	Experienced clinician with ASD expertise Caregiver	PMP
Rohacek A. *et al.* 2023[24] (b)	Pilot RCT	USA	6 weekly sessions, 120 min each, plus 1 follow-up session after 6 months	9 caregivers of children with ASD (5–9 years) Weight not assessed	Reducing child's challenging behaviours, caregiver stress, and improving caregiver mental health functioning	Psychoeducation	Group sessions	Experienced clinician with ASD expertise Caregiver	PSP

Table 3. (*Continued*)

	Study design	Area and setting	Duration and frequency	Sample characteristics	Programme objectives	Type of intervention	Individual/ group sessions	Actors involved	PSP*/PMP†
Cosbey J. *et al.* 2017[27]	Pilot study	USA (home)	9–21 sessions, according to the child	3 children (6–8 years old) and their families Weight not assessed	Expanding dietary variety and reducing challenging behaviours	Behavioural strategies, sensory-based strategies and communication support	Individual sessions	Occupational therapist Speech and language pathologist certified in behaviour analysis Caregiver	PMP
Trewin A. *et al.* 2022[35]	Descriptive study	USA	At the discretion of parents	Parents of 5 children (2–8 years old) Weight not assessed	Educating parents about the sensory integration factors that can contribute to feeding difficulties	Sensory-based intervention	Individual sessions	Caregiver	PSP
Sharp W. G. *et al.* 2014[36]	Pilot RCT	USA (home)	8 weekly sessions, 60 min each	10 families with children aged 3–8 years old Weight assessed	Reducing challenging child's behaviours and caregiver stress and expanding dietary variety	Behavioural intervention	Group sessions	Behavioural psychologist Postdoctoral psychology fellow Caregiver	PMP
Muldoon D. *et al.* 2018[55]	Follow-up on a pilot study	USA (clinical setting)	31–36 twice-a-week sessions, 50 min each, for no more than 6 months	3 children (3–5 years old) and their caregivers Weight not assessed	Expanding dietary variety and reducing challenging behaviours	Behavioural strategies, sensory-based strategies and communication support	Individual sessions	Registered behaviour technician Speech and language pathologist certified in behaviour analysis Caregiver	PMP
Sharp W. G. *et al.* 2019[56] **(a)**	RCT	USA (home and clinical setting)	10 sessions over 12 weeks, 90 min each plus 1 booster session after 2–4 weeks plus 1 follow-up session after 1 month	Parents of 38 children (3–8 years old) Weight assessed	Reducing child's challenging behaviours and caregiver stress and expanding dietary variety	Behavioural intervention	Group sessions	Behavioural psychologist Postdoctoral psychology fellow Dietitian Caregiver	PMP
Sharp W. G. *et al.* 2019[56] **(b)**	RCT	USA	10 sessions, 90 min each	Parents of 38 children (3–8 years old) Weight assessed	Reducing child's challenging behaviours and caregiver stress and expanding dietary variety	Psychoeducation	Group sessions	Psychologist trained at reliability Caregiver	PSP
Matheson B. E. *et al.* 2019[57]	Pilot study	USA (home)	16 weekly sessions, 60 min each, plus 1 session with parent–child	Parents of 20 children (6–13 years old) Weight assessed	Promoting weight loss and increasing intake of fruits and vegetables and physical activity	Behavioural intervention	Group sessions	Clinical psychologist Expert in movement-based instruction for children with ASD Caregiver	PMP

Legend: The programmes shown in the table are colour coded: in green are programmes aimed only at individuals with ASD, and in blue are those involving parents/caregivers. Area and setting: identifies the location of the study and the setting of the programme's sessions. Duration and frequency: identifies the number of sessions held and the frequency with which they were conducted (e.g. weekly, biweekly . . .). Sample characteristics: identifies the number of study participants, age and whether a weight assessment was conducted. Programme objectives: identifies the goals that the programme sets out to achieve. Type of interventions: identifies the strategies implemented in the programme. Individual/group sessions: identifies whether programme sessions are group or individual. Multicomponent: identifies the actors involved during the programme sessions.

* PSP, parent support programme.

† PMP, parent-mediated programme.

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Table 4. Schematic representation of the nutrition education programmes' specific characteristics aimed at an appropriate declination in favour of individuals with ASDs, combined with their relative rationale

Specific characteristic	Examples from the programmes analysed	Rationale
Visualised education (VE)[37–43,45–50,52–54]	- Use of technology (i.e. online lessons, mobile applications, websites and videos) - Printed materials (i.e. ingredient inventories, graphic handouts)	- Known predilection towards the use of these tools by individuals with ASD, underscored by the high rate of screentime[18] - Effectiveness of video-based interventions in youth with ASD[70,71]
Experiential learning (EL)[37,45–50,52–54]	- Cooking classes (i.e. making fresh pasta by hand or preparing salad etc.), proposing basic or simplified recipes with few steps, directions for safe kitchen use (stove, oven etc.), and using adaptive tools (i.e. knife with facilitated handle) - Tasting sessions (including creating a personalised Food Dictionary) - Grocery shopping	- Exposure therapy to reintroduce new or disliked foods, given the high prevalence of FS in the ASD population[72] - (For cooking and tasting sessions) strategies for addressing disliked organoleptic food features - (For cooking classes) powerful combination of health promotion and life skills training[41] to help overcome the reduced manual dexterity frequently found in individuals with ASD - (For cooking classes) to encourage the reuse of recipes in daily practice
Goal setting[43–46,52–54]	First for a targeted food exposure or maintaining a regular mealtime schedule or for eating healthy foods, then reinforcing meeting goals or long-term goals	- Promotion of the knowledge transition of the concepts provided during class (from a theoretical and/or practical perspective) into their home life
Homework assignment[39,43–49,51,54]	- Practising healthy food exposure and/or behavioural techniques - Took photos of foods with the programme app	- To involve parents as facilitators towards concepts ultimate internalisations, resulting in a lasting behavioural change
Language and communication[37–50,52–54]	- Simplified language (both in verbal instructions and in the materials provided) - Calm verbal assurance and directions ('First this, then this')	Simplification of the learning process and the concepts internalisation, given the frequent presence of intellectual impairment in the population with ASD[2]
Songs[41]	Simple group songs	- Skill enhancement to facilitate multistep processing among the ASD population[41,73] - To establish joint attention and to build social engagement[41]
Games[38,47–49,54]	- Parent–child games during tasting sessions	Efforts to add higher spontaneously and fun to the learning process
Predictable rituals, routines and/or schedules[41–43,52–54]	- Class rituals and routine (i.e. written agendas, visual schedules and sequencing of activities in a predictable order) - Mealtime routines and eating schedule	- Generally appealing for individuals with ASD[43] - Useful for self-regulation[43] - As a form of priming[53]
Behavioural techniques[43,53,54]	- Cognitive behavioural treatment (CBT) - Applied behavioural analysis (ABA)	Counteracting behavioural inflexibility and need for sameness, frequent in individuals with ASD, which are in direct contrast to the variability of eating experiences[43]
Reinforcement strategies[42,43,45,46,50,52–54]	Positive reinforcement (rewards): f.e. 'punch cards', where punches can then be traded in for a prize previously identified	Facilitation of the learning process including integration of healthy eating habits into one's eating habits[53,74]
Sensory environment[47–49,52,53]	- Non-sensory stimulating, calm and supporting[52] - Provision of a relaxing additional room[47–49] - Inclusion of relaxing activities (i.e. arts and crafts projects, whole-body movements) in between[53]	- Sensory issues present a significant challenge for ASD individuals, especially within a classroom setting, affecting their learning efficiency and behavioural control[75] - To allow children overwhelmed by sensory stimuli to relax[47–49] - To anticipate sensory overstimulation[53]
Involvement of facilitators[37,38,42–50,52–54]	- Parents[42–50,52–54] - Child's behavioural interventionist[52] - Early intervention providers[42] - School teacher[37,38]	Modelling, role-playing[43] and dyadic activities for favouring the internalisation of the new behaviour[76,77])

difficulties in individuals with ASD. Concerning the two programmes that did not support parental involvement[22], one was behavioural, whereas the other was sensory-based.

The duration and frequency of intervention varied across programmes, with the number of sessions ranging from a minimum of 6 to a maximum of 36 weeks. The session frequencies ranged from less than once a week to weekly, biweekly, three times a week and an intensive option of ten sessions in one week. Among the programmes, four out of ten[24,36,56,57] PMPs and two out of three[24,56] PSPs supply group sessions; while programmes that do not involve parents provide individual sessions.

The professional figures involved in the programmes were mainly psychologists, speech and language therapists, and certified therapists in applied behaviour analysis (ABA). Only two out of fifteen programmes[23,56] had the presence of dietitians. It is worth noting that anthropometric assessment was conducted in seven out of fifteen[20,21,36,55,57] programmes.

In terms of programme objectives, the fundamentals were: (i) reducing children's challenging mealtime behaviours (12/15 programmes)[20–24,27,36,55,57], (ii) expanding dietary variety (9/15 programmes)[20,22,27,36,55,57] and (iii) reducing caregivers' stress (7/15 programmes)[21,23,24,36,56].

In terms of results, studies that compared behavioural interventions with other types showed greater effectiveness of behavioural ones. In Rohacek A. *et al.* (2023)[24], a blinded evaluator used the Clinical Global Impression-Improvement (CGI-I), a clinician-rated scale that tracks changes in global functioning and response to treatment, to compare the behavioural PMP and the PSP. CGI-I reported a statistically significant improvement in the former compared with the latter[24]. In addition, the rates of treatment acceptability and satisfaction were higher in the behavioural PMP and during the follow-up period, and the decrease in depressive symptoms was maintained in the behavioural PMP, whereas no such maintenance was observed in the group assigned to the PSP[24]. In the study by Peterson K. M. *et al.* (2016), children who were assigned to the behavioural intervention showed an increase in their consumption of target foods, whereas this was not observed in the group that received the sensory-based intervention[22]. However, treatment generalisation was observed in two of the three children who initially participated in the sensory intervention and were subsequently assigned to the behavioural intervention[22]. Therefore, the implementation of the behavioural intervention after the sensory intervention resulted in a potential treatment generalisation effect[22]. In the study of Sharp W. G. *et al.* (2019), a higher rate of improvement was observed in the behavioural PMP compared with the PSP[56]. This improvement was measured using the CGI-I scale by a blinded independent evaluator[56]. Meanwhile, children participating in the behavioural PMP showed significantly lower scores on the Brief Autism Mealtime Behavior Inventory (BAMBI) at both week 12 and week 16[56]. The group assigned to the behavioural PMP showed an increase in the grams consumed during the meal observations at both times, and a decrease was observed in the group assigned to the PSP at each timepoint[56]. At 20-week follow-up, the CGI-I score remained unchanged from week 16 levels for twelve participants of the behavioural PMP (80 %)[56].

Finally, in Marshall J. *et al.* (2015) study favourable outcomes were achieved regardless of intervention type (behavioural or sensory-based), but although the differences were not statistically significant, it is important to note that from a clinical point of view participants in the behavioural PMP demonstrated greater improvement in dietary variety compared with the sensory-based PMP[20].

Conclusion

Various nutritional interventions are documented in the literature aimed at individuals with ASD, including those aimed at reducing FS in individuals with ASD and those aimed at enhancing their dietary quality and food choices.

Regarding the former, no study has analysed the long-term impact. They mainly focused on assessing feasibility in improving symptoms related to social and behavioural areas, as well as dietary habits. However, programmes that aim to improve dietary quality may have limited effectiveness if the individuals they target show marked FS, so the strength of such programmes lies in implementing strategies that take this into account as well.

Considering programmes aimed at reducing FS, there is currently no gold-standard approach. However, behavioural strategies are associated with significant improvements in eating behaviour. One limitation of these programmes is that, in their effort to expand the eating repertoire of individuals with ASD, healthy foods are not consistently introduced at the outset of treatment sessions. Consequently, the path to improvement may be prolonged, necessitating the later implementation of a programme specifically targeting the enhancement of food quality.

In conclusion, this narrative review provides the reader with a better understanding of the nutrition interventions implemented to date for individuals with ASD, divided into nutrition education programmes and those aimed at reducing FS. It highlights the need to test the effectiveness of the former since this aspect is missing in the literature and provides a starting point for the implementation of further studies to define the role of sensory-based interventions, communication support and psychoeducational approaches in reducing FS.

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Competing interests

The authors declare no conflicts of interest.

Authorship

Conceptualisation: Maria Vittoria Conti, Sara Santero, Chiara Breda; methodology: Maria Vittoria Conti, Sara Santero, Chiara Breda; writing – original draft preparation: Sara Santero, Chiara Breda; writing –review and editing: Maria Vittoria Conti, Sara Santero, Chiara Breda; visualisation: Hellas Cena; supervision: Hellas Cena. All authors have read and agreed to the published version of the manuscript.

References

1. Sharma SR, Gonda X & Tarazi FI (2018) Autism spectrum disorder: classification, diagnosis and therapy. *Pharmacol Ther* **190**, 91–104.
2. American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*. Washington, DC: American Psychiatric Publishing.
3. Ahumada D, Guzmán B, Rebolledo S, *et al.* (2022) Eating patterns in children with autism spectrum disorder. *Healthcare* **10**, 1829.
4. Hyman SL, Levy SE, Myers SM, *et al.* (2020) Identification, evaluation, and management of children with autism spectrum disorder. *Pediatrics* **145**, e20193447.
5. Şahan AK, Öztürk N, Demir N, *et al.* (2021) A comparative analysis of chewing function and feeding behaviors in children with autism. *Dysphagia* **36**, 993–998.
6. Bandini LG, Anderson SE, Curtin C, *et al.* (2010) Food selectivity in children with autism spectrum disorders and typically developing children. *J. Pediatr* **157**, 259–264.
7. Valenzuela-Zamora AF, Ramírez-Valenzuela DG & Ramos-Jiménez A (2022) Food selectivity and its implications associated with gastrointestinal disorders in children with autism spectrum disorders. *Nutrients* **14**, 2660.
8. Raspini B, Prosperi M, Guiducci L, *et al.* (2021) Dietary patterns and weight status in italian preschoolers with autism spectrum disorder and typically developing children. *Nutrients* **13**, 4039.
9. Luçardo JDC, Monk GF, Dias MDS, *et al.* (2021) Interest in food and triglyceride concentrations in children and adolescents with autistic spectrum disorder. *J Pediatr* **97**, 103–108.
10. Wang Z, Ding R & Wang J (2020) The association between vitamin d status and autism spectrum disorder (ASD): a systematic review and meta-analysis. *Nutrients* **13**, 86.
11. Baj J, Flieger W, Flieger M, *et al.* (2021) Autism spectrum disorder: trace elements imbalances and the pathogenesis and severity of autistic symptoms. *Neurosci Biobehav Rev* **129**, 117–132.
12. Gallardo-Carrasco MC, Jiménez-Barbero JA, Bravo-Pastor MDM, *et al.* (2022) Serum vitamin D, folate and fatty acid levels in children with autism spectrum disorder: a systematic review and meta-analysis. *J Autism Dev Disord* **52**, 4708–4721.
13. Srikantha P & Mohajeri MH (2019) The possible role of the microbiota-gut-brain-axis in autism spectrum disorder. *Int J Mol Sci* **20**, 2115.
14. Leader G, Barrett A, Ferrari C, *et al.* (2021) Quality of life, gastrointestinal symptoms, sleep problems, social support, and social functioning in adults with autism spectrum disorder. *Res Dev Disabil* **112**, 103915.
15. Gilmore GD, Longo A & Hand BN (2022) The association between obesity and key health or psychosocial outcomes among autistic adults: a systematic review. *J Autism Dev Disord* **52**, 4035–4043.
16. Li YJ, Xie XN, Lei X, *et al.* (2020) Global prevalence of obesity, overweight and underweight in children, adolescents and adults with autism spectrum disorder, attention-deficit hyperactivity disorder: a systematic review and meta-analysis. *Obes Rev* **21**, e13123.
17. Dhaliwal KK, Orsso CE, Richard C, *et al.* (2019) Risk factors for unhealthy weight gain and obesity among children with autism spectrum disorder. *Int J Mol Sci* **20**, 3285.
18. Jones RA, Downing K, Rinehart NJ, *et al.* (2017) Physical activity, sedentary behavior and their correlates in children with autism spectrum disorder: a systematic review. *PLoS ONE* **12**, e0172482.
19. Mandecka A & Regulska-Ilow B (2022) The importance of nutritional management and education in the treatment of autism. *Roczniki Panstwowego Zakladu Higieny* **73**, 247–258.
20. Marshall J, Ware R, Ziviani J, *et al.* (2015) Efficacy of interventions to improve feeding difficulties in children with autism spectrum disorders: a systematic review and meta-analysis. *Child Care Health Dev* **41**, 278–302.
21. Johnson CR, Foldes E, DeMand A, *et al.* (2015) Behavioral parent training to address feeding problems in children with autism spectrum disorder: a pilot trial. *J Dev Phys Disabil* **27**, 591–607.
22. Peterson KM, Piazza CC & Volkert VM (2016) A comparison of a modified sequential oral sensory approach to an applied behavior-analytic approach in the treatment of food selectivity in children with autism spectrum disorder. *J Appl Behav Anal* **49**, 485–511.
23. Johnson CR, Brown K, Hyman SL, *et al.* (2019) Parent training for feeding problems in children with autism spectrum disorder: initial randomized trial. *J Pediatr Psychol* **44**, 164–175.
24. Rohacek A, Baxter EL & Sullivan WE (2023) A preliminary evaluation of a brief behavioral parent training for challenging behavior in autism spectrum disorder. *J Autism Dev Disord* **53**, 2964–2974.
25. Sharp WG, Jaquess DL, Morton JF, *et al.* (2010) Pediatric feeding disorders: a quantitative synthesis of treatment outcomes. *Clin Child Fam Psychol* **13**, 348–365.
26. Bloomfield BS, Fischer AJ, Dove M, *et al.* (2021) Parent teleconsultation to increase bites consumed: a demonstration across foods for a child with ARFID and ASD. *Behav Anal Pract* **14**, 913–926.
27. Cosbey J & Muldoon D (2017) EAT-UP™ family-centered feeding intervention to promote food acceptance and decrease challenging behaviors: a single-case experimental design replicated across three families of children with autism spectrum disorder. *J Autism Dev Disord* **47**, 564–578.
28 Esposito M, Mirizzi P, Fadda R, *et al.* (2023) Food selectivity in children with autism: guidelines for assessment and clinical interventions. *Int J Environ Res Public Health* **20**, 5092.
29 Rodrigues JVS, Poli MCF, Petrilli PH, *et al.* (2023) Food selectivity and neophobia in children with autism spectrum disorder and neurotypical development: a systematic review. *Nutr Rev* **81**, 1034–1050.

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https://doi.org/10.1017/S0954422424000052 Published online by Cambridge University Press

30. Białek-Dratwa A, Szymańska D, Grajek M, *et al.* (2022) ARFID-strategies for dietary management in children. *Nutrients* **14**, 1739.
31. Chehade M, Meyer R & Beauregard A (2019) Feeding difficulties in children with non-IgE-mediated food allergic gastrointestinal disorders. *Ann Allergy Asthma Immunol* **122**, 603–609.
32. Fishbein M, Cox S, Swenny C, *et al.* (2006) Food chaining: a systematic approach for the treatment of children with feeding aversion. *NCP* **21**, 182–184.
33. Bearss K, Burrell TL, Stewart L, *et al.* (2015) Parent training in autism spectrum disorder: what's in a name? *Clin Child Fam Psychol Rev* **18**, 170–182.
34. Hodges AK, Hathaway KL, McMahon MXH, *et al.* (2023) Treatment of feeding concerns in children with autism spectrum disorder: a systematic review of behavioral interventions with caregiver training. *Behav Modif* **47**, 936–958.
35. Trewin A, Mailloux Z & Schaaf RC (2022) Evaluation of mealsense: a sensory integration-based feeding support program for parents. *Am J Occup Ther* **76**, 7603345020.
36. Sharp WG, Burrell TL & Jaquess DL (2014) The autism MEAL plan: a parent-training curriculum to manage eating aversions and low intake among children with autism. *Autism* **18**, 712–722.
37. Shurack RH, Garcia JM, Brazendale K, *et al.* (2022) Brief report: feasibility and acceptability of a remote-based nutrition education program for adolescents with autism spectrum disorder: a COVID-19 pilot study. *J Autism Dev Disord* **52**, 4568–4574.
38. Garcia JM, Cathey B, Shurack R, *et al.* (2021) Evaluation of a nutrition education and culinary program for adolescents with autism spectrum disorder. *J Nutr Educ Behav* **53**, 987–990.
39. Garcia JM, Shurack R, Leahy N, Brazendale K, Lee E & Lawrence S (2023) Feasibility of a remote-based nutrition education and culinary skills program for young adults with autism spectrum disorder. *J Nutr Educ Behav* **55**, 215–223
40. Veneruso M, Varallo G, Franceschini C, *et al.* (2022) Short report. Cooking for autism: a pilot study of an innovative culinary laboratory for Italian adolescents and emerging adults with autism spectrum disorder. *Res Dev Disabil* **126**,104259.
41. Goldschmidt J & Song HJ (2017) Development of cooking skills as nutrition intervention for adults with autism and other developmental disabilities. *J Acad Nutr Diet* **117**, 671–679.
42. Gray HL, Pang T, Agazzi H, *et al.* (2022) A nutrition education intervention to improve eating behaviors of children with autism spectrum disorder: study protocol for a pilot randomized controlled trial. *Contemp Clin Trials* **119**,106814.
43. Kuschner ES, Morton HE, Maddox BB, *et al.* (2017) The BUFFET program: development of a cognitive behavioral treatment for selective eating in youth with autism spectrum disorder. *Clin Child Fam Psychol Rev* **20**, 403–421.
44. Burrell TL, Sharp WG, Criado KK, *et al.* (2020) Feasibility of a structured, multidisciplinary intervention for weight management in children with autism spectrum disorder. *Semin Pediatr Neurol* **35**,100830.
45. Buro AW, Gray HL, Kirby RS, *et al.* (2022) Pilot study of a virtual nutrition intervention for adolescents and young adults with autism spectrum disorder. *J Nutr Educ Behav* **54**, 853–862.
46. Buro AW, Gray HL, Kirby RS, *et al.* (2022) Parent and adolescent attitudes toward a virtual nutrition intervention for adolescents with autism spectrum disorder. *Adv Neurodev Disord* **7**, 94–106.
47. Thorsteinsdottir S, Njardvik U, Bjarnason R, *et al.* (2021) Taste education – a food-based intervention in a school setting, focusing on children with and without neurodevelopmental disorders and their families. A randomized controlled trial. *Appetite* **167**, 105623.
48. Thorsteinsdottir S, Njardvik U, Bjarnason R, *et al.* (2022) Changes in eating behaviors following taste education intervention: focusing on children with and without neurodevelopmental disorders and their families: a randomized controlled trial. *Nutrients* **14**, 4000.
49 Thorsteinsdottir S, Bjarnason R, Eliasdottir HG & Olafsdottir AS. (2023) Body composition in fussy-eating children, with and without neurodevelopmental disorders, and their parents, following a taste education intervention. *Nutrients* **15**, 2788.
50. Ketcheson LR & Pitchford EA (2021) Promoting physical activity participation and nutrition education through a telehealth intervention for children on the autism spectrum and their caregivers. *Contemp Clin Trials* **107**, 106496.
51. Espinoza J, Chen A, Orozco J, *et al.* (2017) Effect of personal activity trackers on weight loss in families enrolled in a comprehensive behavioral family-lifestyle intervention program in the federally qualified health center setting: a randomized controlled trial. *Contemp Clin Trials Commun* **7**, 86–94.
52. Espinoza JC, Deavenport-Saman A, Solomon O, *et al.* (2021) Not just at school: Inclusion of children with autism spectrum disorder in a weight management program in a community pediatric setting. *Autism* **25**, 642–655.
53. Manzanarez B, Garcia S, Iverson E, *et al.* (2021) Lessons in adapting a family-based nutrition program for children with autism. *J Nutr Educ Behav* **53**, 1038–1047.
54 Kral TVE, O'Malley L, Johnson K, *et al.* (2023) Effects of a mobile health nutrition intervention on dietary intake in children who have autism spectrum disorder. *Front Pediatr* **11**, 1100436.
55. Muldoon D & Cosbey J (2018) A Family-centered feeding intervention to promote food acceptance and decrease challenging behaviors in children with ASD: report of follow-up data on a train-the-trainer model using EAT-UP. *Am J Speech Lang Pathol* **27**, 278–287.
56. Sharp WG, Burrell TL, Berry RC, *et al.* (2019) The autism managing eating aversions and limited variety plan vs parent education: a randomized clinical trial. *J Pediatr* **211**, 185–192.e1.
57. Matheson BE, Drahota A & Boutelle KN (2019) A pilot study investigating the feasibility and acceptability of a parent-only behavioral weight-loss treatment for children with autism spectrum disorder. *J Autism Dev Disord* **49**, 4488–4497.
58. Murimi MW, Kanyi M, Mupfudze T, *et al.* (2017) Factors influencing efficacy of nutrition education interventions: a systematic review. *J Nutr Educ Behav* **49**, 142–165.
59. Murimi MW, Moyeda-Carabaza AF, Nguyen B, *et al.* (2018) Factors that contribute to effective nutrition education interventions in children: a systematic review. *Nutr Rev* **76**, 553–580.
60. Li X, Huang Y, Yin R, *et al.* (2019) Visualized nutrition education and dietary behavioral change: a systematic review and meta-analysis. *Crit Rev Food Sci Nutr* **59**, 1976–1985.
61. Hasnin S, Saltzman JA & Dev DA (2022) Correlates of children's dietary intake in childcare settings: a systematic review. *Nutr Rev* **80**, 1247–1273.
62. Charlton K, Comerford T, Deavin N, *et al.* (2021) Characteristics of successful primary school-based experiential nutrition programmes: a systematic literature review. *Public Health Nutr* **24**, 4642–4662.
63. De Medeiros GCBS, De Azevedo KPM, Garcia D, *et al.* (2022) Effect of school-based food and nutrition education interventions on the food consumption of adolescents: a systematic review and meta-analysis. *Int J Environ Res Public Health* **19**, 10522.

https://doi.org/10.1017/S0954422424000052 Published online by Cambridge University Press

64. Nikolaus CJ, Muzaffar H & Nickols-Richardson SM (2016) Grocery store (or supermarket) tours as an effective nutrition education medium: a systematic review. *J Nutr Educ Behav* **48**, 544–554.
65. Murimi MW, Nguyen B, Moyeda-Carabaza AF, *et al.* (2019) Factors that contribute to effective online nutrition education interventions: a systematic review. *Nutr Rev* **77**, 663–690.
66. Angawi K & Gaissi A (2021) Systematic review of setting-based interventions for preventing childhood obesity. *Biomed Res Int* **2021**, 4477534.
67. Meiklejohn S, Ryan L & Palermo C (2016) A systematic review of the impact of multi-strategy nutrition education programs on health and nutrition of adolescents. *J Nutr Educ Behav* **48**, 631–646.
68. Zablotsky B, Black LI & Blumberg SJ (2017) Estimated prevalence of children with diagnosed developmental disabilities in the United States, 2014-2016. *NCHS Data Brief* **291**, 1–8.
69. Dewar DL, Lubans DR, Plotnikoff RC, *et al.* (2012) Development and evaluation of social cognitive measures related to adolescent dietary behaviors. *Int J Behav Nutr Phys Act* **9**, 36.
70. Sam AM, Cox AW, Savage MN, *et al.* (2020) Disseminating information on evidence-based practices for children and youth with autism spectrum disorder: AFIRM. *J Autism Dev Disord* **50**, 1931–1940.
71. de Nocker YL & Toolan CK (2023) Using telehealth to provide interventions for children with ASD: a systematic review. *Rev J Autism Dev Disord* **10**, 82–112.
72. Kuschner ES, Eisenberg IW, Orionzi B, *et al.* (2015) A preliminary study of self-reported food selectivity in adolescents and young adults with autism spectrum disorder. *Res Autism Spectr Disord* **15-16**, 53–59.
73. Geretsegger M, Fusar-Poli L, Elefant C, *et al.* (2022) Music therapy for autistic people. *Cochrane Database Syst Rev* **5**, CD004381.
74. Ledford JR, Zimmerman KN, Harbin ER, *et al.* (2018) Improving the use of evidence-based instructional practices for paraprofessionals. *Focus Autism Other Dev Disabilities* **33**, 206–216.
75. Deng L & Rattadilok P (2022) A sensor and machine learning-based sensory management recommendation system for children with autism spectrum disorders. *Sensors* **22**, 5803.
76. DeCosta P, Møller P, Frøst MB, *et al.* (2017) Changing children's eating behaviour – a review of experimental research. *Appetite* **113**, 327–357.
77. Jansen PW, de Barse LM, Jaddoe VWV, *et al.* (2017) Bi-directional associations between child fussy eating and parents' pressure to eat: who influences whom? *Physiol Behav* **176**, 101–106.

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