Systematic Review in Interventions for eating difficulties in children with autism spectrum disorders

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Systematic review on interventions treating eating difficulties in children with autism spectrum disorders.

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Abstract

Autism spectrum disorder (ASD) is a neurodevelopmental disorder, characterized by deficits in sociability, behaviour and communication. Children with autism spectrum disorder often face eating difficulties. Those difficulties might be accompanied by disruptive behaviours. Individuals with autism and their families might therefore be negatively influenced by such eating difficulties.

The aim of the present research was to examine the interventions available in the literature in order to treat eating difficulties children with ASD display. Therefore, the following research questions were formulated: What interventions exist for treating eating difficulties in children with ASD? What techniques are effective in treating eating difficulties in children with ASD? Are interventions that include parents more effective in treating eating difficulties in children with ASD compared to those that do not include parents?

To answer the research questions, a systematic literature review was conducted. The PICO system was used to establish the search term of the review. The quality of the selected studies was assessed by two independent reviewers, using a combination of methodological quality assessment tools.

Regarding the first research question, eleven interventions were available for eating difficulties in children with ASD. The other two research questions failed to be answered. No specific technique was found as effective in treating eating related difficulties, yet the combination of techniques was used among the studies. Reinforcement accompanied by other techniques, constitutes promising results. None of the studies compared interventions which include parents and not include parents.

Based on this, it is recommended that further research is needed to be performed, provided with more rigorous research designs in order to test the effectiveness of techniques and parental component in the interventions treating eating difficulties in children with ASD.

Introduction

Food neophobia

Food neophobia is characterized by a restricted variety in food preference and consumption, especially with regard to fruits and vegetables, hesitation in eating unfamiliar food (De Almeida et al.,2020), and less pleasure from food intake (Kaar et al., 2016). Food neophobia is caused by various factors, genetics being an important one (Anjos et al.,2021). Research in various countries has shown that food neophobic behaviours are estimated to occur in between 40% and 60 % of children below the age of 18 years, while the majority of children that display this behaviour are in the pre-school age range (De Almeida et al.,2020). As a result of food neophobic behaviour, children may have nutritional inadequacies and abnormal -for their age- weight (Gonzalez & Stern, 2016).

Aside from food neophobia, children often display other eating and feeding difficulties, like picky eating (Mascola et al., 2010). Picky eating refers to strong eating preferences and lack of motivation to eat certain foods, mostly fruits and vegetables (Mascola et al., 2010). In DSM 5 eating and feeding difficulties are included in the same category as eating related disorders, which affects food consumption, physical and psychological health (American Psychiatric Association, 2013). Eating difficulties are often present also in children with autism spectrum disorder (Gray et al., 2022; Hubbard et al., 2014 & Keen, 2008). It is estimated that those behaviours are present in 46% - 89% of children with ASD (Ledford & Gast, 2006). In addition, eating difficulties in children with ASD, might have an effect on the way their family functions (Kabasaka et al.,2021 & Zhu & Dalby-Payne, 2019). Mealtimes may become challenging, and hence caregivers face significant stress levels (Gonzalez & Stern 2016 & Zhu & Dalby-Payne 2019). Therefore, for the

current thesis a systematic review of interventions for feeding difficulties in children with autism spectrum disorder was conducted.

Children learn to eat through a complex process based on several individual and environmental factors (Gonzalez & Stern, 2016). The variety and quality of food consumption are established early on in childhood and are associated with food preferences in adolescence and adulthood (De Almeida et al.,2020). Between the ages of two and six, children are likely to manifest food neophobia most often (De Almeida et al., 2020). A question can arise from that information is about the reason food neophobia begins. Scientific evidence has shown that evolutionarily, humans are more reluctant to taste new food due to food poising danger. Preschool years are the age range when children start tasting a variety of new foods. Hence, this might explain why it is more likely for preschool children, rather than older ones, to manifest food neophobic behaviours (Anjos et al.,2021). Extreme food refusal results in avoidant/restrictive food intake disorder (ARFID) (Baraskewich et al.,2021). ARFID was established as a disorder recently since it is included for the first time in the DSM-5 as an eating disorder. It is characterized by nutrition deficiency, difficulty in gaining weight or extreme weight loss and dependence on tube feeding. There is evidence indicating that autism spectrum disorders co-exist with ARFID between 3 and 13% (Kambanis et al., 2019)

Eating difficulties in autism spectrum disorders

Autism Spectrum Disorder is a neurodevelopmental disorder characterized by deficits in social communication and repetitive behaviour patterns (American Psychiatric Association, 2013), accompanied by sensory processing difficulties (WHO, 2023), phenomena which start occurring in preschool-aged children (American Psychiatric Association, 2013). The severity of symptoms varies within the

population, hence the use of the term spectrum (WHO, 2023). The prevalence of autism is 1 out of 100 children (WHO, 2023).

As mentioned, more than 40% of children with ASD have feeding and eating difficulties. They are more likely than their typically developing peers to express food selectivity and refusal due to food characteristics (Gray et al., 2022 & Hubbard et al., 2014 & Keen, 2008). In typically developing populations food selectivity occurs in 25% of the cases (DeMand et al., 2015). The severity of food selectivity among children with ASD can vary between mild, moderate and severe (Kabasaka et al.,2021). Food refusal can be accompanied by inappropriate mealtime behaviours like spitting food, holding food in the mouth, refusing to open the mouth or even showing aggressive behaviour toward others and themselves (Tanner & Andreone, 2015). The aggression is more likely to be present in children with ASD having eating difficulties, than in children without such eating difficulties (Leader et al., 2020).

The three major symptoms of autism spectrum disorder, (the behavioural, social and sensory processing deficits), are associated with developing those difficulties. Regarding behavioural difficulties, ASD children display certain preferences in the regularity of food in appearance and taste (Zhu & Dalby-Payne, 2019). Concerning their social deficits, children with ASD might experience anxiety, due to an environment which alters frequently, and some children seem unable to understand other people's perspectives, known as theory of mind. People with ASD cannot understand others' emotions and frequently seem emotionally unavailable. Another reason might provoke challenging mealtimes is the fact that some children cannot understand, in a social aspect, what is the emotional and behavioural impact to their parents and caregivers, due to their maladaptive mealtime behaviours. Last but not least, children with autism face sensory deficits, such as hypersensitivity in certain

smells and textures. Such sensory deficits, could lead to food refusal (Zhu & Dalby-Payne, 2019).

Fruits and vegetables are more likely to be limited or even lacking from the diet of children with autism. At the same time, carbohydrates tend to be over-represented (Hubbard et al., 2014 & Zhu & Dalby-Payne, 2019). Concerning autistic selective eaters, compared to typically developing or autistic groups, which do not display selective eating behaviour, over 70% of children do not adequately consume important nutrients like vitamins A, D, and calcium (Zimmer et al., 2012). Moreover, poor dietary habits in childhood, raise the danger of obesity, which leads to severe health problems in adulthood, such as heart disease and diabetes (Gray et al., 2018; Gray et al.,2022; Kral et al., 2013 & Zhu & Dalby-Payne, 2019).

In addition to the possible impact the eating difficulties of children with ASD have (Gonzalez & Stern, 2016), there might be a negative impact on family function (Kabasaka et al.,2021 & Zhu & Dalby-Payne, 2019). Parents and caregivers often display significant levels of stress, due to challenging mealtimes (Gonzalez & Stern 2016 & Zhu & Dalby-Payne 2019). Thinking of the long-term effects of food refusal, such as health related impact, caregivers face certain emotional difficulties when the try, unsuccessfully to feed their children. The relationship between parents and their children can also be influenced (Gonzalez & Stern, 2016). Conflicts between family members and negative home environment, may occur (Burrell et al., 2022 & Zhu & Dalby-Payne, 2019). Prolonged feeding time is needed, and as a result either siblings or the parents themselves may be forced to alter their own mealtime's routine. Furthermore, due to the limited food variety, parents frequently prepare several meals for the family (Zhu & Dalby-Payne, 2019).

Caregivers use different strategies in order to convince children to eat. They often use external motives to distract children, such as videos or games as reinforcements to motivate their children to eat, while they might also use children's preferable food as a reward. Unfortunately, when food is used as a reward, it is connected with different stimuli rather than hunger, resulting in an ineffective feeding strategy, which increases the eating difficulties, due to the fact that children end up not eating when they are hungry (Kral et al., 2015). Children's problematic eating behaviours accompanied by parents' inappropriate feeding strategies may result in weight-associated problems in youth (Kral et al., 2015). Parents should respond to their children in a responsive way, by trying to be patient and not using harsh strategies to make their children behave in a certain way. Responsive and non-responsive parental feeding strategies, in childhood, can also affect children's response to food (Van Vliet et al., 2021b). As mentioned, eating difficulties in autism can be accompanied by disruptive behaviours. If those behaviours appear constantly, parents may succumb to their children's maladaptive behaviours and provide their preferred food in order to comfort them. That strategy reinforces children's behaviour and children may learn that maladaptive behaviours are effective and use them in different contexts to avoid other unwanted circumstances (Gonzalez & Stern, 2016). The impact of this situation is apparent in siblings and their behaviour. Parents use them as positive eating behaviour models. That results in a psychological impact to siblings, due to the fact that they become teachers and it is not uncommon for siblings to display inappropriate behaviour (Zhu & Dalby-Payne, 2019).

Early treatment for feeding difficulties in children with ASD is necessary to increase food intake and is recommended in the entire spectrum of food selectivity (mild- moderate- severe) (Bloomfield et al., 2021). Research has shown that

especially early interventions based on behavioural theories are very promising for treating those difficulties (Gray et al.,2022). Furthermore, the involvement and training of parents in interventions may help for achieving optimal intervention outcomes, enforcing parental involvement in that process (Trewin et al., 2022; Burrell et al., 2022 & Bloomfield et al., 2021), since, as we have already mentioned, they already apply feeding strategies to their children, but sometimes unsuccessfully.

Therefore, the present systematic review aims to answer the following research questions:

- What interventions exist for treating eating difficulties in children with ASD?
- What techniques are effective in treating eating difficulties in children with ASD?
- Are interventions that include parents more effective in treating eating difficulties in children with ASD compared to those that do not include parents?

Methods

The present systematic review is part of a larger review. The latter was focused on all available prevention and intervention programs for food neophobia in pre-school aged children, as mentioned in the literature. Our review focused on the intervention programs for eating difficulties for the specific population of children with autism spectrum disorders (ASD). Firstly, we will describe our search for the broader review and following we will describe our specific search.

Primary search

Empirical studies and reviews published in English were searched to find prevention and intervention programs for children having food neophobia and other

feeding and eating difficulties. For that purpose, two master students searched for data under the guidance of a university teacher on internet databases. The two independent reviewers (AP and MSI), in order to formulate the search term, used the PICO concept (Richardson et al., 1995); the population (P) targeted in the studies needed to be children aged 0 to 6 years old; the prevention or intervention programs (I) needed to focus on food neophobia or picky eating; and the prevention and intervention program needed to aim to increase food acceptance (O). The comparison (C) criterion was not included in the search term because we were also interested in intervention studies without control groups. The team searched until the 12th of December 2022 in the following internet databases: PubMed, Web of Science, PsycINFO and Medline. The used search term was: (child* OR infan* OR pre-school* OR preschool* OR baby OR babies OR toddler*) AND ("food neophobia" OR food-neophobia OR "picky eat*" OR "choosy eat*" OR "feeding difficulties" OR "feeding difficulty" OR "eating difficulty" OR "eating difficulties" OR "selective eat*" OR "fussy eat*" OR "avoidant restrictive food intake disorder" OR ARFID OR "food avoid*" OR "vegetable acceptance" OR "fruit acceptance" OR "food pickiness" OR "food rejection") AND (interven* OR preven* OR treatment* OR program*). After this search, EndNote software was used for extracting the studies and removing the duplicates. The total number of gathered studies was 7.196. After duplicates were deleted, the remaining number of studies was 2.060.

Inclusion and exclusion criteria

The inclusion and exclusion criteria for the larger systematic review were formulated as follows; the reviewers were looking for empirical papers written in English in peer reviewed journals and focusing on prevention or intervention programs targeting children between the ages of 0 and 6, who experience food

neophobia or refuse to eat various foods. Studies referring to children suffering from medical conditions, like children with cancer and cerebral palsy, interventions taking place at hospitals and pharmacological treatments, were excluded from the review. However, interventions that partly took place at hospitals due to children's food neophobia or eating difficulties were not excluded. Furthermore, programs including children aged higher than 6 years old, were included only if the mean age of the children in the program was up to 6 years old. Before screening the whole set of 2.060 studies, each student screened the first 100 for eligibility using the in- and exclusion criteria described above. This screening resulted in a 97% of agreement and a Cohen's kappa of .84. Through discussion, the limited disagreement was resolved. The final number of included studies was 284.

Search strategy for the present thesis

AP independently screened the 284 hits to select studies relevant to her research questions. AP was interested in intervention programs for feeding difficulties concerning the population of children with autism spectrum disorder (ASD). Specifically, inclusion criteria were a) empirical studies referring to b) children with ASD, c) aged between 0 to 6 years old, d) containing information on existing interventions, (home or institution or school- based) using specific strategies or the combination of various strategies aiming to increase variety in food acceptance. After this screening, 10 studies were used for this review, and one more added from reference check. In Table 1, more details about the screening of the studies are available.

Table 1. Risk of bias assessment

	Yes	No	Non-applicable
Is the sample representative of the population that the intervention is designed for?			
Is a control group used?			

a. Are the control group and intervention group comparable on demographic and clinical characteristics?			
b. Was randomization performed appropriately?			
What is the quality of the outcome measure related to child eating used in the study?			
a. A validated measure was used			
b. A reliable measure was used			
c. It is possible to reproduce the measurement			
What is the quality of the description of the intervention in the paper?			
a. Clear techniques are described in the paper			
b. It is possible to reproduce the intervention based on the description in the paper			
How was missing data handled?			
a. Missingness of data is described			
b. Missingness of data does not lead to bias			
Were appropriate statistical tests performed?			
Were there any deviations from the intended interventions?			
a. Was the intervention implemented successfully for most participants?			
b. Did study participants adhere to the assigned intervention regimen?			

Data extraction

All data and intervention characteristics were extracted from the interventions. Regarding study characteristics, research design, number of children, age of children and their parents, a definition of children's eating difficulties, study country, and location, were extracted. Furthermore, regarding intervention characteristics, duration of the intervention, number of sessions and intervention goals and the measures that were used to analyse the effects was also investigated. Lastly, parental involvement was examined by looking for details about their training and involvement.

Methodological quality assessment

Two reviewers (AP and MSI) independently scored the quality of the selected studies. Since the study designs of our studies vary largely, we assessed the methodological quality of the studies based on an instrument used by a systematic review by Van der Veek and colleagues, that also compared various research designs (Van der Veek et. al., 2011) and the ROBINS-I tool (AC Sterne et.al., 2016). Seven topics were reviewed, with several sub criteria per topic (Appendix 1.):

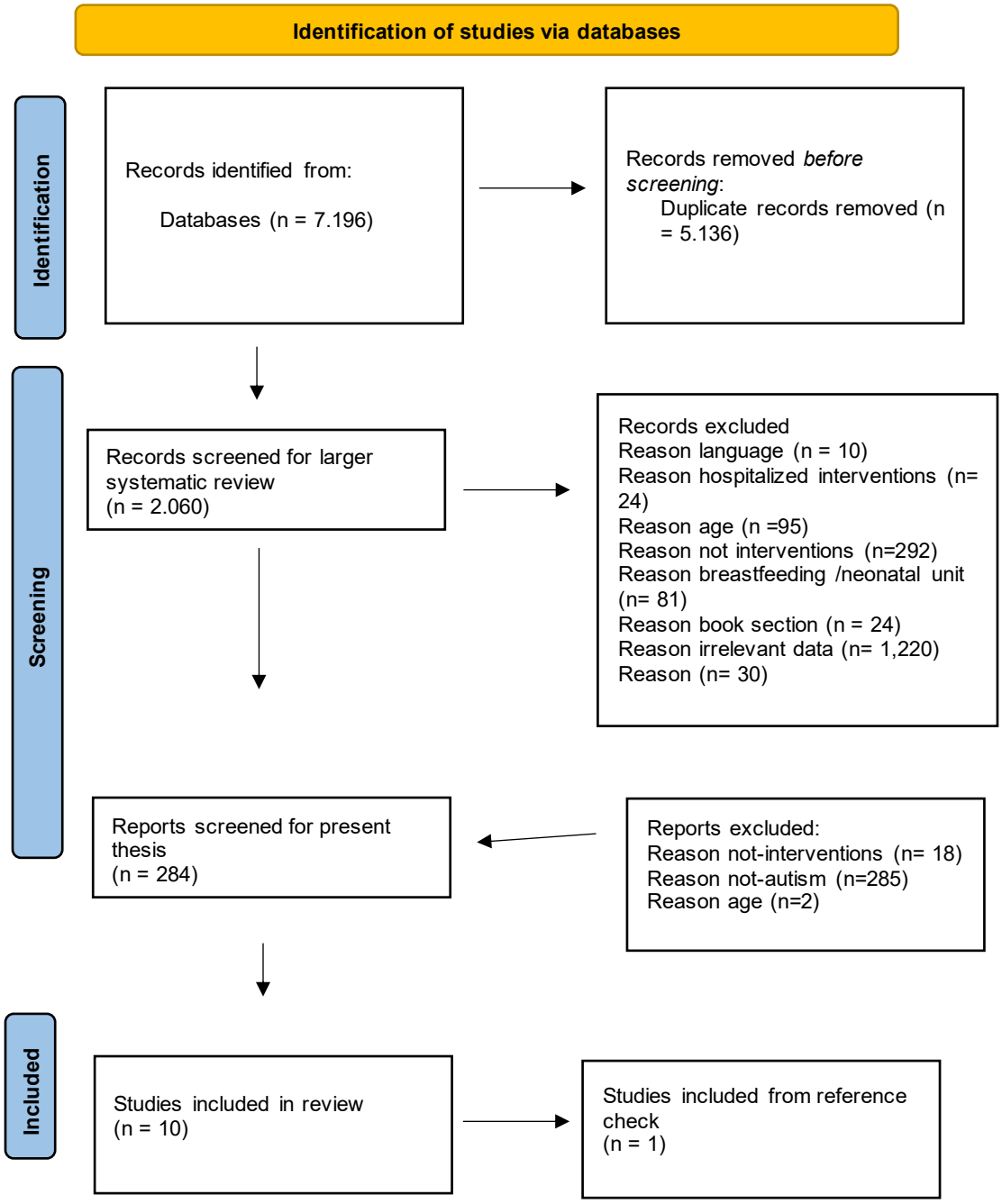
1. Representativeness of the intervention groups for the population
2. Representativeness of the control group (if used; i.e., comparability of control group and intervention group on demographic and clinical characteristics)
3. Quality of the outcome measurement related to child eating (validity and reliability of the measurement and the possibility of measurement reproduction)
4. Quality of intervention's description (clarity of described techniques and intervention's reproduction possibility)
5. Presence and handling of missing data (description of missing data and the possibility of those data leading to bias)
6. Performance of appropriate statistical tests
7. Deviations from the intended interventions (whether or not the interventions were implemented successfully for most participants and to what extend participants adhere to the assigned intervention regimen).

Answer options were yes, no and non – applicable. The interobserver reliability was 84,62%. Cohen's kappa revealed substantial agreement between the two reviewers, k =.731, $p < .000$. Disagreement between the independent reviewers was resolved through discussion.

Lastly, in order to be able to structure the different techniques that were used in the interventions, we used two taxonomies on behavior change techniques. In those taxonomies behavior methods and techniques are specified, with the purpose of becoming a valuable tool for interveners. The first one was Abraham and Michie's (2008), and the second was the one by Eldredge et al. (2011).

Table 1.

Flow diagram of study selection process



Results

The research questions will be answered in the following paragraphs. A more detailed description of the findings can be found in the tables in the Appendix section.

The interventions

Within the 11 studies that were examined, various interventions were found. The majority included behavioral components, which will be explained in detail in the next section.

Each study had different characteristics. There were two studies having one participant (case studies), three studies having up to five participants, while the rest having from 19 up to 48 participants. The research designs also varied among the studies. The present review included one randomized controlled trial, two study protocols and the rest of the studies have used many different designs, most of them qualitative. Only six studies included outcome measures. The range of the children's age was between 0 and 8 years old. Parental component was included for 55% of the studies. Parents needed to be adults and, in most cases, they were over 30, while in most cases their age was rarely mentioned. More details about the parental component, intervention goals, main results, and the above-mentioned characteristics can be found in the Appendices (Tables 1-8).

Risk of bias

In Appendix 9, an overview of the risk of bias assessment is provided. The sample was representative only for 18% of the studies. Control groups and appropriate randomization to the groups were available in 18% of the studies. Valid and reliable measures were used in 64% of the studies; the reproduction of the

measurement was possible in these studies. The percentage of studies that managed to describe clearly the used techniques, was 64%. The reproduction of the interventions based on the description was possible for 54% of the studies. In only 9% of the studies the missing data were described and that missingness could lead to bias in 9% of the studies. Almost half of the studies (45%) performed appropriate statistical tests. Furthermore, 36% of the studies were tested, presenting to have clear evidence concerning the successful implementation of the interventions. Lastly, 45% of the studies were also tested, resulting in evidence that the participants adhere to the assigned intervention regimen.

Used techniques

In the abovementioned interventions, many techniques were examined, which will be described below. Some techniques were used in multiple studies and will be presented firstly, while other techniques that were used only once will be presented thereafter.

Before discussing the specific techniques, it should be mentioned that the number of sessions, along with their duration, varied among the studies. Not all the studies indicated duration; no consistent duration was observed for those who indicated one. In Bloomfield and colleagues (2012), five 50-minute weekly sessions took place, while in Gale and colleagues (2010), 5 feeding sessions within the same day (at 10:45 am, 12:00 pm, 2:00 pm, 3:15 pm, and 4:30 pm) were implemented. Furthermore, the following sessions took place: ten 25-minute weekly lessons in the study of Gray and colleagues (2022), 4 hours per day (3 hours of behavior therapy, and 1 hour of oral motor therapy) for five or seven days in the study of Laud and colleagues (2009), while the control condition in Sharp and colleagues (2019) had ten 90-minute sessions. Lastly, in the study of Taner & Anderone (2015) the sessions

lasted 20 minutes, and in the study of Weber & Gutierrez (2015) two to four weekly 1-hour sessions were performed.

Shared techniques

Reinforcement

The basic concept in the behavioral interventions was reinforcing the child each time it displayed the behavior that was asked to perform, such as biting the given food. Differential reinforcement of alternative behavior (DRA) was used in Bloomfield and colleagues (2021). With DRA, a positive behavior that is used as an alternative of an inappropriate one, is reinforced. Condition of continuous reinforcement schedule (CRF) used in Congdon (2013), in order for the participant to have contingent access to the reinforcer. In addition, vocal praise, social reinforcement, access to preferred toys and consumption of preferred food were used among the rest of the interventions, as alternative reinforcement techniques.

Another characteristic we came across in the available studies, referring to the reinforcers, was the establishment of them, providing the opportunity to the children to choose, on their own, the reinforcement of their preference. In Taner & Andreone (2015), the experimenter assessed the preferred foods and items which could be used as possible reinforcers. In addition, an array of toys was provided to the children in order for them to choose their reinforcers. In Yamane and colleagues (2020), the mealtime diet was established according to the initial assessment of the way children choose to eat.

An alternative way of reinforcement was the token-board system. The token-board is a system where the child exchanges positive behavior with one preferred sticker. In order to make the token-board, a plastic paper with a certain number of

stickers, that are preferred by the child, is needed. Velcro material is used in order to place the images on the board. For each positive behavior, the child gains one sticker, which is then placed on the board. Once the child has gained a certain number of stickers, the child's preferred reinforcement becomes available.

Hierarchy

Reinforcement accompanied other techniques, with hierarchy being one of them. That additional technique was used in two studies. Bloomfield and colleagues (2021), used a 6-step demand feeding hierarchy, aiming to establish self-feeding. Each step started with a different verbal prompt, and different behavior was asked. The parents needed to reinforce every hierarchy step, starting from the level that children had the higher demand level of acceptance, during the baseline procedure. That reinforcement needed to be decreased for previous steps as the participant continued with the next one. A fixed reinforcement ratio, from 1 to 10, was established. In order to move on to the next step, the participant should have shown compliance for at least five trials in a row. Once the demand was succeeded, the parents should reinforce the participant with vocal praise and provide a preferred toy for 1 minute. In Taner & Andreone (2015), a 12-step hierarchy was used as the primary technique. The experimenter led the participant to each step by modelling the target behavior, while the participant should imitate that behavior. Tokens were used as differential reinforcers, reinforcing the appropriate behavior without reinforcing the inappropriate one. In case where a child refused one step of the hierarchy, the experimenter should backslide into two levels of the hierarchy, aiming to finish the trial with the participant's independent feeding.

Interval of reinforcement access

As mentioned earlier, children were granted access to reinforcers, such as toys, when they correctly displayed the target behavior. The duration the children could play with that reinforcer differed among the studies, varying form 5 seconds (Congdon, 2013), to 10 seconds (Bloomfield et al., 2021), to 30 seconds (Gale et al., 2010; Weber & Gutierrez, 2015), to 90 seconds (Congdon, 2013) and a 3-minute break (Taner & Andreone, 2015).

Response interval

Another technique which we came across in many studies, was the fixed interval for the participant to respond. That means, that participants needed to display the target behavior a few second after the intervener's command. If there was no response at a specific time interval, no reinforcement was given. For the studies of both Bloomfield and colleagues (2021) and Congdon (2013), the participants had to respond to the given vocal and/or model prompt within 10 seconds. Lastly, in Gale and colleagues (2010) each trial lasted 30 seconds, so regardless participant's reaction, the spoon remained at a certain distance from the participant's mouth (2.5 cm) for 30 seconds.

Escape extinction

An additional technique that was used was the escape extinction. In the study of Congdon (2013), escape extinction was used only for one participant. In case of no acceptance, the researcher held the spoon near participant's lip until the participant accepted. The researcher ignored on purpose the refusal behaviors, and in case where the participant attempted to disrupt the food presentation, another researcher blocked his hands gently. In case of a large size of food thrown out of the mouth, the food was picked up again or replaced, and the researcher provided the verbal prompt "Finish

your bite" while holding the spoon to the child's lip. In that way, the child did not have the opportunity to escape from that situation. The same technique was used in Gale et al. (2010) study. The parent or tutor could prevent the spoon from being pushed away by placing their arms, gently, across the children's hands. If the child succeeded in pushing it away, the food was immediately replaced in the spoon.

Parent training

For some interventions, parents were trained to implement them at home. In some cases, the intervention could also be implemented by an expert (Trewin et al., 2022), while in some others, the experts only trained the parents, so the latter were able to implement the intervention successfully (Bloomfield et al., 2021; Burrell et al., 2022; Gray et al., 2022; Sharp et al., 2019).

In the interventions that were implemented only by parents, the latter were informed about the needed concepts, such as the origins of the difficulties, rather than get trained to specific techniques. More specifically, in Burrell and colleagues (2022), Gray and colleagues (2022), Sharp and colleagues (2019), and in Trewin and colleagues (2022) the interveners informed parents about ASD and feeding and eating difficulties rather than implementing specific behavioral techniques to treat problematic eating behaviors. Gray and colleagues (2022) described that during the lessons, the providers informed parents about specific feeding strategies for children with ASD, like making mealtime routines and activities with a behavioral and nutritional focus. Every lesson had different objectives, such as feeding milestones, sensory properties of foods, introducing new foods, etc.

Trials

In addition, many studies referred to the number of trials. Trials are the number of attempts the intervener makes to stimulate the participant to eat the provided food. In Bloomfield and colleagues (2021), the trial was each feeding demand beginning with a vocal prompt (touch, hold, kiss, lick, bite, or consume). Five trials of each food are needed. In Congdon (2013), researchers used sessions with 10 trials. In Weber & Gutierrez (2015), the experimenter was advised to have only five trials within one session. The rest of the session can be used for other purposes.

Vomit/Gagging handling

In two studies, specific ways to respond to vomiting and/or gagging were formulated. For Gale and colleagues (2010), in the case where children vomited, the table was cleaned, and the children were offered a glass of water. Then the session is continued. In Taner & Andreone (2015), there was a specific protocol in case of gagging behavior. The intervener was instructed to move two steps back in the hierarchy in order to complete the task and reinforce the child. If certain foods provoked a gagging response for four sessions, they were removed.

Modelling

Furthermore, in two studies the modelling technique was provided. In modelling the intervener displays the target behaviour in order to be used as a model and the participant to imitate that behavior. An interval of 10 seconds was also used. In Taner & Andreone (2015), the experimenter led the participant to each step by modelling the target behavior, while the participant should imitate that behavior.

Techniques used only once

Some techniques were not common in all the interventions. Bloomfield and colleagues (2021) aimed to increase food acceptance and succeed in self-feeding. Through the hierarchy, which has already been mentioned, the intervener needed to alter the food-related demand that the child had to do, for each step, commencing from a basic level, which was to just touch the food, up to consume the food.

Furthermore, the same study used the least-to-most prompt to increase compliance. With that technique, the intervener provides fewer prompts in the beginning and gradually increases that support, in order to help the participant display the target behavior. In the aforementioned study, that technique was used only when the participant did not show compliance within the first 10 seconds after the vocal prompt.

In Taner & Andreone (2015), in case where there was no compliance towards the requested demand, the parent used the technique of physical guidance (physical prompt) without reinforcement. Parents did not put the food into their children's mouth. In the case of modelling and vocal prompt, the attempt was considered successful; whereas in the case of physical prompts, the attempt was considered unsuccessful.

The Burrell's (2022) study, provided parents with scripts made by therapists, activities for caregivers, like role plays, and handouts with helpful information about each session's topic, for example the explanation of monitoring mealtime behavior. During the fifth session, the psychologists, who led the sessions, also provided in-vivo coaching to parents live during feeding time, with the other participants of the group observing.

In Congdon's (2013) study, a primary technique was used, which was high-probability (-p) request sequences. High-p request sequences involve three to five instructions with at least 80-100% of compliance for every given opportunity, followed by a request which is less probable to occur. The children are asked, for three to five times in a row, to bite or consume a food that it is highly possible for them to eat. This technique aims to structure a certain behavior momentum of compliance. The researcher asked three high-p requests quickly, sitting in front of the participant, before the low-p request of "take a bite of the non-preferred food". Praise was given after high-p request responses, and five seconds later, the low-p request was delivered. In case of no response to high-p requests, the researcher continued the high-p requests until at least two, in a row, had a response. The participant could have access to the reinforcer, after they had completed successfully all the steps. After that, a food-related high-p request enhanced condition was delivered. In the enhanced condition a maximum of 3-trials was delivered for each high-p request in a row. Then again, a maximum of 3 high-p request trials were delivered, and the procedure followed until the termination of 10 trials.

In Gale and colleagues (2010), the technique of non-contingent negative reinforcement was used. This means that the spoon was removed after 30 seconds and that the session will end after 20 presentations, in case the child hasn't eaten. As described above, in case the child tried to push the spoon away, the spoon remained in the same position until the end of the trial.

Laud and colleagues (2009), studied an intensive interdisciplinary feeding program. The participants had 3 hours of daily behavior therapy and 1-hour of daily oral motor therapy for five to seven days. The behavior therapy entailed systematic meal sessions, having individualized behavior protocols with antecedent and

consequence manipulation in the meal. Antecedent-behavior-consequence (A-B-C) was used for challenging feeding behavior recording. A-B-C is a tool which is used to observe and collect direct information about circumstances that take place within a child's environment, in order to have a clear picture of what was the target behavior that provoked disruptive behavior, aiming to terminate it. Oral motor therapy was implemented in order to reassure children's skills and safety while eating. The speech or occupational therapist trained the children with nutritive and non-nutritive oral motor exercises. No further explanation for the intervention was given in that study.

The study of Trewin and colleagues (2022), describes the "*MealSense@*" program outline. The module begins with a video, where parents can find the introduction of the program, the definition of feeding and all the sensory aspects which are connected to the feeding. Furthermore, it can be found the mealtime environment that the parents should have in order to implement the intervention, along with the interaction that they should have with their children and the technique of the "just-right challenge", for which no information was provided. In that study, no further information about the intervention details was given.

In the study of Weber & Gutierrez (2015), three behavioral techniques were used, which are: shaping, sequential presentation and simultaneous presentation.

In shaping, the intervener should reinforce the successive approximations of a target behavior which, in the present study, had seven steps. Firstly, therapists should ask the participants to put the food on their hands. Then the children need to touch their cheek, nose, lips and tongue with the food. Next, the participant bites down the food and finally eats it. Each step should be done independently.

For the sequential presentation, the aim is children to be motivated to eat by consistently presenting the edible reinforcement children will get after their success on the give task. The intervener needs to have two colored circles on the table, as a visual presentation. In the left circle the target food is placed, and in the right one the preferred and tangible items are placed. The therapist asks the child to perform the needed shaping step (vocal prompt) and then informs the child about what it could earn after completing that order/task. Shaping and sequential presentations take place together. If the combination does not lead to success for the last step of shaping, then simultaneous presentation is used.

In the simultaneous presentation, the non-preferred foods and the select items needed to be presented in the left side of the table. Then the therapist needed to put all the preferred foods on the right side of the table. Gradually the amount of non-preferred foods was increased on the left side of the table until both sides had the same amount. The foods need to be cut into chewable bite-size, in order for the children to eat them easily.

Lastly, in the study of Yamane and colleagues (2020), a diet based on nutritional consultation is used. The participants were divided into three groups. The first group was composed of children who chose to eat based on sensory factors. Children in the second group chose their food based on colors, shapes or cooking methods. In the third group, children made their choice based on their familiarity with the foods. Consequently, the diet was accustomed to children's preferences. The experimenters used those characteristics to make specific diets. Initially, they offered children the foods according to their preferences; however, those characteristics gradually changed. For instance, in case where children preferred deep fried foods, in

the beginning they were provided with what they wanted, yet at a later stage they were gradually offered with shallow fried food.

Effectiveness of techniques

The next research question concerned the effective techniques for treating eating difficulties in children with ASD. In our search, we met many different techniques, with the majority being behavioral. The standard case for most of the studies, concerning the positive effect, included a combination of several techniques, rather than the implementation of only one.

The variety of research designs was proved to be a rather unsuitable tool for the investigation of effective techniques. The way the results were measured and presented also varied among the studies. Only five studies included statistical analysis; for these studies a certain level of confidence can be indicated, concerning the effectiveness of techniques. The other six studies provided descriptive statistics to give an indication of effectiveness.

The following studies presented the results of the statistical analysis they conducted. Burrell and colleagues (2022) analyzed the data for the 19 randomly assigned children to the MEAL Plan. The intervention had a positive, but not statistically significant, effect. After the treatment, 11.1% of the children that experienced a positive effect, manifested disruptive behaviors. In the opposing group (children that experienced a negative effect), the corresponding percentage was at 42.9%. However, the factors that led to that outcome are yet to be determined. The authors have indications that the effectiveness resulted due to factors other than the techniques used. More specifically, both maternal education and the children's greater functional communication were presented to be strong mediators.

The statistical analysis for the MEAL Plan intervention was also available in the randomized controlled trial. Sharp and colleagues (2019) indicated that during the 16th week, 47.4% of the participants were significantly rated as much improved. In the control group, only 5.3% succeeded to improve. At the same time, the standard mean difference in disruptive behaviors was significantly decreased. In the MEAL Plan, where parent training was included, entailed useful information about the eating related difficulties in autism, training in intervention implementation and generalization of the positive outcome.

In the study of Laud and colleagues (2009), there is also evidence for a statistically significant difference, and most specifically increase in food acceptance, grams consumption, and, surprisingly, in refusal behaviors. It is also mentioned that the negative vocalization was significantly decreased, as well as the total eating problems. In that intervention a combination of behavior and oral/motor therapies was implemented, whereas no further information was provided.

Statistical analysis was also conducted in the study of Yamane and colleagues (2020), providing statistically significant improvement in the participants. However, no further details were available in the paper.

The rest of the studies used descriptive statistics to indicate the interventions' effects. In Bloomfield and colleagues (2021), the participant increased after the intervention, her food consumption in terms of absolute mean from three to ten bites. In Congdon (2013), the three participants increased the consumption of non-preferred foods by 70, 80 and 100%, respectively. In Gale and colleagues' (2010) study, all three participants improved their food acceptance in the trials. While, in the baseline, the absolute intake, in the range of 20 trials, was about 0.0, 0.6 and 0.0, after the

intervention the acceptance which occurred in the mean trials was 16.5, 18.3 and 6.2, respectively. Additionally, in Tanner and Andreone (2015) the participants' food acceptance increased from 4 to 50 types of food.

There were two studies, which provided very little information about the effectiveness of the techniques, due to their research design. Gray and colleagues (2022) and Weber & Gutierrez (2015) provided a study protocol, so no data was presented in the papers. Lastly, Trewin and colleagues (2022) examined the efficacy of "*MealSense@*" based on parents' and experts' opinions, while no further information about the effectiveness of the techniques was provided. Overall, the examined aspects were positively rated by both experts and parents, with the latter claiming that they would suggest that program.

A technique, which can be considered as effective was the reinforcement technique. There is a level of confidence to characterize that technique as effective, since it was used among, almost, all the studies. Positive or negative reinforcement, given in various ways, like contingent or non-contingent reinforcement, accompanied by other techniques, was used to increase the probability of positive behaviors and decrease the probability of negative behaviors. In many studies, the researchers, like Weber & Gutierrez (2015) indicated that reinforcement could moderate the effect of an intervention. It is certainly difficult to conclude that this technique is effective, due to the lack of statistical analysis.

Parental involvement

The final research question was whether or not the interventions which included parents were more effective compared to those without them. Six out of eleven studies included the parental component. According to our review, no study

has compared so far interventions with and without parental components, however, we attempted to compare the effectiveness of the parental component among these conducted studies. The studies of Gray and colleagues (2022), Trewin and colleagues (2022), and Weber & Gutierrez (2015) were excluded from that comparison, since they did not provide any data on effectiveness. Therefore, eight studies were finally compared.

To begin with, there was an attempt to compare the studies that included parents and those that did not include parents. Congdon (2013), Tanner and Andreone (2015), Laud and colleagues (2009), and Yamane and colleagues (2020) did not include parents in their studies. In all the aforementioned studies, except the one by Yamane and colleagues (2020), in which no clear evidence is stated, an absolute increase in food acceptance was observed. Only in the study of Laud and colleagues (2009), a statistical analysis was available and this was significant.

On the other hand, in the studies conducted by Bloomfield and colleagues (2021), Burrell and colleagues (2022), Sharp and colleagues (2019) and Gale and colleagues (2010), in which parents were included, only some of them indicated effective results. Only two of the studies indicated positive effects. Sharp and colleagues (2019) had a statistically significant effect on almost half of the participants, and the effect was greater compared to the one in the control group. In Gale and colleagues (2010), no statistical test was provided, but the pre-post measurement had a large difference. Burrell and colleagues' (2022) study mentioned that the results were not statistically significant. In the study of Bloomfield and colleagues (2021), there was a certain increase in food acceptance, yet that increase was fairly larger in the preferred foods, compared to the lower increase in the non-

preferred food. As a result, questions about the effectiveness of parental involvement in interventions like that arose.

Interesting comparisons were made as well, among emerged studies with and without parents, regarding the used techniques. In two studies, the invasive technique of escape extinction, which was extensively discussed earlier, was used in a study where parents partly implemented the intervention (Gale et al., 2010) and in a study where only experts implemented the intervention (Congdon, 2013). Both interventions were characterized as successful; however, the results of higher acceptance in the first study depicted a 17.7 absolute mean, compared to a staggering 100% food acceptance in the second one.

Even though in the other two studies the use of hierarchy technique was implemented, the results when only the experts were used can be characterized as more promising. More specifically, in Bloomfield and colleagues (2021), the parents used a six-step hierarchy, managing an increase of food consumption in 5 types of food. On the other hand, Tanner & Andreone (2015) therapists used a 12-step hierarchy in order to increase food acceptance. The increase was significant, from 4 to 50 foods. The increase of the second study is considered higher, since the participant was successfully introduced into 45 new types of food, whereas the participant of the first study managed an increase in the food consumption within 5 types of food.

Discussion

This systematic review has provided insight into treating eating difficulties in children with ASD. This systematic review focused on three main research questions. The first was to investigate which interventions are available in the literature to treat eating difficulties in children with ASD. Eleven studies, having different research

designs and techniques, involving eleven different interventions were available. Following, the effectiveness of the used techniques was examined. Insufficient evidence about the effectiveness of techniques made it impossible to answer that question. The combination of techniques is used to treat those difficulties in the studies. Lastly, the effectiveness of interventions with a parental component compared to those without a parental component was investigated. Unfortunately, no studies made that comparison directly. However, several comparisons based on similar techniques that were used by parents and experts, were made in the current review, resulting in mixed evidence.

Overall, the studies included in the current review had limited sample sizes, the research designs varied, and most of the studies did not include statistical analysis in order to ascertain the reader that the results could be generalized to the population. Therefore, the current study's results are indications, and the research questions have not been clearly answered. Following, further details are available for the findings of this review.

Interventions

The first issue investigated in the current review was how many interventions exist to treat eating difficulties in children with ASD. After the search, 11 interventions emerged. In six studies, parents were trained to implement the intervention, and in some of these, therapists or researchers also implemented the interventions separately from parents. The other five interventions were delivered only by trained researchers.

The level of provided detail, concerning the techniques used, varied among the studies. The studies of Bloomfield and colleagues (2021), Congdon (2013), Gale and colleagues (2010), Gray and colleagues (2022), Taner & Andreone (2015) and Weber & Gutierrez (2015) were very detailed, letting the reader understand all the steps the interveners followed and thus allowing for replication. The other five studies presented a lack of information. Additionally, many interventions used behavioral techniques, which aimed to alter inappropriate behaviors.

These results are in line with the broader literature investigating interventions for eating difficulties in children with ASD. In the review of Hodges and colleagues (2022), behavioral techniques are used to treat, in a clinical setting, eating difficulties in the population of children with autism, due to the high efficacy that the behavioral interventions have in autism.

Nevertheless, behavioral interventions are not the only approach to treat eating and feeding difficulties in autism. Other approaches are also available in the literature, like interventions manipulating sensory and environmental factors (Miyajima et al., 2017). The study of Trewin and colleagues (2022), which is included in the current review, is in that direction.

Effectiveness of techniques

The second research question concerned which techniques effectively treat eating difficulties in children with ASD. All studies used a combination of techniques rather than a technique alone to treat eating difficulties effectively. That might indicate that one technique cannot treat those difficulties alone; hence, further research is needed. There was no consistency in the techniques used among the

interventions. Most interventions used techniques delivered from learning theories, like Social cognitive theory. Learning theories suggest that organisms learn when their behavior changes due to prior experiences (De Houwer et al., 2013). Social cognitive theory suggests that learning is based on the interaction of personal, behavioral and environmental factors (*International Encyclopedia of Education*, 2022). Regarding the examined interventions, those theories were incorporated by creating healthy mealtime plans, accompanied by behavior-changing techniques and a positive relationship between the intervener and the child.

Reinforcement

Each intervention implemented different techniques, like modelling in which the intervener displays the wanted behavior and the children need to imitate that behavior, or fixed intervals in which interveners wait for the child to respond in order to reinforce or correct the behavior. The only technique that was present in most of the interventions was reinforcement. Reinforcement was used to increase the probability of repeating the target behavior and to reduce unfavored behaviors. Reinforcement was provided in several ways, such as positive, negative and contingent reinforcement. The effectiveness of the reinforcement technique is also mentioned in the broader literature, as the review by Marshall and colleagues (2015) indicates. In that review, reinforcement is considered to be a necessary part of the majority of the interventions described in treating eating-related difficulties in young children with ASD. Furthermore, reinforcement was used almost in every intervention, while the interventions resulted in increasing food acceptance.

Moreover, the effectiveness of differential reinforcement in children with ASD, who display eating difficulties and maladaptive behaviors, has also been

examined in the review of Ledford and Gast (2006). Differential reinforcement reinforces the desired behaviors without simultaneously reinforcing the undesired. Several studies in that review suggested that when differential reinforcement was accompanied by other techniques, rather than alone, it can effectively treat eating-related difficulties in children with ASD (Ledford & Gast, 2006). In the abovementioned study, there was no intention to investigate the effectiveness of specific techniques, like the present review. Several techniques were described, and therefore, no confident conclusions can be made.

Intrusive techniques

As has already been mentioned, several techniques were used in the studies, with some of them being intrusive and others non-intrusive techniques. Non-intrusive techniques are connected with sensitive parenting. Sensitivity, which is the responsiveness towards children's stress without the use of harsh strategies for discipline, is recommended to be used by parents as a method to promote emotional development and the development of executive functions in children (Werchan et al., 2022). In the available studies, most of the described techniques were more sensitive and not intrusive, like the high probability request sequence, in which the intervener starts the program by asking the children to display probable behaviors, followed by asking children to display unfavorable behaviors accompanied with reinforcement.

However, in two studies, the technique of escape extinction was used, which can be characterized as rather insensitive and very intrusive, as interveners needed to block children's hands in order for them not to throw the food away and keep the spoon near children's lips during the fixed time the intervention was taking place. Intrusive techniques are available in the broader literature, aiming to treat eating-

related difficulties in children with ASD. For instance, in the study of Zhu & Dalby (2019), the technique of escape extinction has been studied extensively. In that study, that technique is considered to be -in some cases- necessary, and effective (Zhu & Dalby-Payne, 2019). Ledford and Gast (2006) also refer to escape extinction as a way to prevent children from escaping from the demand, used as an effective technique in increasing food acceptance in reviewed studies. Nevertheless, using such an intense technique might raise ethical issues, and parents seem to be unable to appropriately use it, so further research can provide alternatives to that technique (Ledford and Gast, 2006).

Parental inability that could arise to apply intrusive techniques is partly confirmed in the examined studies. In the study where only experimenters implemented the intervention, it achieved 100% success in food acceptance, compared to cases where parents implemented the interventions, in which total food acceptance did not occur throughout all the sessions, but in the majority.

Several techniques are generally examined to increase food and especially fruit and vegetable consumption in typically developing children. The repeated exposure technique, which aims to increase familiarity with certain types of food, is used for food consumption increase. In the studies of De Wild et al. (2017) and Owen et al. (2018), repeated exposure effectively increased the liking and consumption of targeted foods. That evidence could be the starting line for researchers to investigate the efficacy of that technique in children with autism spectrum disorders for increasing fruit and vegetable consumption.

Parental component

The last research question was if interventions which include parents are more effective than those that do not include parents. None of the reviewed studies compared interventions including parents and interventions that did not include parents, so no direct answer is available. Parents indicated an increase in the variety of foods and a decrease in disruptive behaviors in most studies, regardless of their own participation in the intervention. In two of the interventions parents implemented, the results were moderate compared to the large effects interventions implemented by experimenters suggested, regardless of the technique used.

In contrast, the available literature concerning interventions for children with ASD indicates highly positive outcomes when parents are involved. In the review of Aponte and colleagues (2019), in which parents were trained to treat feeding problems in children with ASD, parents were included in the feeding intervention after the therapist had started, and the interventions proved effective for the children. The difference between the studies in the current review and the revie of Aponte and colleagues (2019), was that in the current review parents were involved form the beginning of the intervention, and not after the experts had started.

That difference in the effects among the reviewed studies and the broader literature might have emerged for various reasons. Due to participants ' young age, the small number of available studies in the present review might be an important reason for that outcome. Furthermore, in the present review, parents get involved in the intervention from the beginning, providing a new insight since, in the broader literature, parents got involved later on in the process; that reason might also explain the mixed evidence.

Furthermore, in two studies escape extinction technique was used. As has already been mentioned, when experts implemented the technique, there was a 100% positive treatment outcome. Another explanation, rather than the inability of parents to apply intrusive techniques in their children, can be derived from other reasons. In the study of Cihon and colleagues (2020), it is stated that using that technique raises ethical issues for the family members, and the experimenters cannot be confident that parents use that technique appropriately (Cihon et al., 2020). However, in the case study of Tarbox and colleagues (2010), in which a parent-implemented intervention using the escape extinction technique for a child with autism and eating difficulties, the child succeeded in increasing its food acceptance and maintained that result (Tarbox et al., 2010).

The comparison was made regarding the two studies of Bloomfield and colleagues (2021) and Taner & Andreone (2015), which used the hierarchy technique, providing a more successful outcome when only experimenters implemented the intervention. The broader available literature presents supporting evidence in regard with parental component success. In the study of Koegel and colleagues (2011), which was not available to the current review since the age of the participants was higher than our target age-range, and in which the parents of three children with autism implemented the intervention using hierarchy, the children increased food acceptance and flexibility (Koegel et al., 2011).

The difference in the studies which are included in our review might arise from the fact that the in the intervention in which parents implemented the intervention, they used six steps in hierarchy, while experts used twelve. Maybe more steps are needed to result in successful outcome.

Overall, the last research question does not have a direct answer. Further research directly comparing interventions that do and do not include parents is needed to be able to answer this question.

Limitations of the evidence included in the review

During this process, some limitations of the evidence included in the review were discovered. Many of them were methodological limitations. First of all, the number of available studies was limited. The results could be more compelling if more studies were available in the literature. Furthermore, the sample sizes within the studies were also limited. Some of them were case studies, or they had less than five participants. The largest study included 48 participants. Therefore, the generalizability of the results is very limited. Another issue is the lack of follow-up evidence in most of the studies. Without examining long-term effects, it is risky to imply that a technique or an intervention is effective for the population, and side effects that might emerge later on cannot be examined. Moreover, not all studies used statistical tests to test whether the intervention effects differed from zero. The results cannot be generalized without such tests, so the validity of the indicated improvement can be questioned.

Another limitation, derived from the quality assessment and implied earlier, is the lack of information on the content of the intervention in some studies. In Yamane and colleagues' (2020) study, the experimenters made special diets for each group of children based on previous evaluations of their eating preferences. The diets were briefly described, and no reliability or validity information was given to clarify that this technique has been used in the past and is appropriate for that population. This study also mentions using statistical analysis, but the analysis itself is not provided.

Also, in Laud and colleagues' (2009) study, only a brief description of the therapy children attended was given. To be able to replicate the study, the reader needs further information about specific techniques used within the sessions and about therapists' training and experience. Additionally, in the study evaluating the MealSense@ intervention, the researchers tried to investigate the intervention's "usefulness". However, there is not enough information available to ascertain how usefulness is scored or the overall intervention's efficacy.

The studies of Sharp et al. (2019), and Burrell et al. (2022), did not provide details about parental training, resulting in difficulty concerning the replication of those studies.

Last but not least, there was no consistency in the severity of eating difficulties the children experienced in the studies. Five out of the eleven studies did not have information about the severity. In four studies, the difficulties were mild to moderate, and in only two, the difficulties were severe. In that way, indicating effective interventions or techniques for certain severity of difficulties is impossible.

Limitations of the current review

The present review also has limitations. First of all, only three databases were used in order to search for studies. Investigation into further databases could have strengthened the present study. Additionally, the studies needed to be published, peer-reviewed, and written in English, possibly constituting a selection bias. Publication bias also might have occurred since unpublished work was beyond this study's scope.

Moreover, medical conditions were excluded from the search. However, there are children with autism and co-occurring medical conditions. So, the current study's

results might not represent that population. Also, no meta-analysis was conducted to examine the present review's effects partially because of the various studies' outcome measurements.

Implications for future research

The current review's results provide the reader with indications of patterns that can be followed to treat eating difficulties in autism. It also constitutes one of the few reviews examining the parental component in eating interventions.

Eating difficulties constitute an issue not only for the autistic population. Typically developing children also display challenging eating-related behaviors; many present food-neophobic behaviors. Several interventions are available for treating those feeding challenges, especially for increasing fruit and vegetable consumption in typically developing children (Dial et al., 2019). Such studies can be used as a starting line for further research about intervention in autistic populations.

Research needs to examine further the treatment of eating difficulties in autism using a more rigorous research design and larger samples. Further research could target investigating strategies that can be used independently, without combining with other techniques, to treat eating-related difficulties. Future reviewers might also target a more autism-related search term, making the search term more specific. In that way, the study sample might be large enough in order for the results to be more solid.

Further research can also be conducted on the techniques. The researchers could examine if the same strategies can effectively treat eating difficulties regardless of the severity of the children's eating difficulties. The effectiveness of the reviewed

techniques in older children with ASD can also be examined. The effectiveness of techniques tested in children with different cognitive/intellectual abilities could be another field of examination.

Lastly, each intervention is implemented in a specific environment. Further research can test the techniques used in different environments like restaurants, which form a great source of stress for parents.

Conclusions

The current systematic review aimed to find which interventions are available in the literature for treating eating difficulties in children with autism spectrum disorders. Limited evidence for treating eating-related difficulties in the autistic preschool population was found. The results matched our expectations of finding existing interventions for treating the abovementioned challenges. However, they did not match our expectations of finding effective techniques to treat eating difficulties and comparisons in intervention efficacy between the interventions where parents implement the intervention versus only therapists and experimenters implementing the intervention.

Overall, this review clearly illustrates the commonly used techniques and interventions for eating difficulties that children with ASD have. Nevertheless, it also raises the question of the effectiveness of these techniques in general and whether a parental component might be of added value. Further research is needed to investigate effective interventions in order to offer less challenges in children's and families' everyday life.

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Appendix

Appendix 1. Description of interventions

Paper	Research Design	N	Age of Children	Age of Parents	Definition of Feeding Difficulties	Country	Duration of Intervention	Sessions Number	Location
Bloomfield et.al, 2021	Qualitative / Single-case	1	5	40	ARFID	Not mentioned	11 weeks	690 trials	Home + clinic
Burrell et. al, 2022	Group-focus Exploratory	19	3-8	Not mentioned	Moderate food selectivity (children eat at least 6 food items), with disruptive mealtime behaviours	Not mentioned	16 weeks	11	Institution
Congdon, 2013	Multiple baselines across subjects with an altemating treatment design	3	3-5	No parents	Limited food repertoire (less than 5 different food in each food group), without severe disruptive mealtime behaviours	United states	Not mentioned	2 10-trial sessions per day 2-3 days per week	School
Gale & Eikeseth, 2010	Non-concurrent multiple baseline design across participants	3	2.5 3.8 4.3	Not mentioned	Limited food intake or/ and only pureed food accepted	Not mentioned	1-3 weeks	Not specified	Home
Gray et. al, 2022	Study protocol for pilot randomized controlled trial	48	0-3	18+	Not severe	United states	10 weeks	10+2	Early intervention institution /online if necessary

Appendix 2. Description of interventions Continued

Paper	Research Design	N	Age of Children	Age of Parents	Definition of Feeding Difficulties	Country	Duration of Intervention	Sessions Number	Location
Laud et. al, 2009	Qualitative	46	3-12 (mean age 5,75)	No parents	Not mentioned	Not mentioned	Average of 47 days	On average 149 sessions for each child	Institution
Sharp et. al, 2019	Randomized Controlled Trial	38	3-7.3	Not mentioned	Moderate (at least 6 foods, at least 1-2 of each food category)	United states of America	16- week trial 1 week post treatment	10 + 3	Institution + Home
Taner & Andreone 2015	Qualitative case study	1	3.5	No parents	Mild	Canada	9 months	100 sessions	Institution
Trewin et. al, 2022	Supplement to direct intervention/Descriptive	5	no children	35-45+	Not mentioned	Not mentioned	Not mentioned	Not specified	Online
Weber & Gutierrez 2015	Protocol	Not specified	2-7	No parents	Not mentioned	United States of America	Not mentioned	2-4 per week	Treatment rooms
Yamane et. al, 2020	Correlational	40	3-6	No parents	Not mentioned	Japan	1-3 years	Not specified	Developmental support centre

Appendix 3. Description of interventions Continue

Paper	Parental factor included	Description of parent component	Intervention goals	Measures used to analyse the effects
Bloomfield et.al., 2021	Yes	Goal setting -Participation in the pre-intervention assessment. - Active learning in order to implement the intervention - Implemented the intervention by presented foods and provide information of consequences, according to therapist suggestion through teleconsultation.	-To test the effectiveness of a home-intervention implemented by parents, focusing on the feeding difficulties of a child with ASD and ARFID, using demand feeding and differential reinforcement.	- Not mentioned
Burrell et.al., 2022	Yes	-Participation on children's assessment -Participation in activities, provided by the psychologist. -Were feeding their children	-Examination of the influence the children's disruptive mealtime behavior has on the MEAL Plan treatment outcome, based on baseline characteristics.	-Brief Autism Mealtime Behavior Inventory (BAMBI) -Clinical Global Impression—Improvement scale, for treatment response - Parent Target Problem narratives & Aberrant Behavior Checklist, to rate CGI-I
Congdon 2013	No	-	-The examination of food related and non-food related high probability request sequences use as interventions aiming to increase food acceptance at school. -The examination of food related request use compared to non- food related requests, in increasing food acceptance at school.	Not mentioned
Gale & Eikeseth, 2010	Yes	-Participated in FAI and FAO -Implemented the intervention regarding the researcher's guidance /carried out the meal, giving consequences and ended the session -Recoded the sessions	-A hypothesis development for effective intervention programs aiming behavioural excess and eating deficits. -The evaluation of a parent-implemented behavioural intervention effectiveness.	Not mentioned

Appendix 4. Description of interventions Continue

Paper	Parental factor included	Description of parent component	Intervention goals	Measures used to analyse the effects
Gray et.al., 2022	Yes	-provide information for baseline -Parents will be trained to implement the intervention -They will provide feedback for the pilot – test -They will receive material from "We Can!" program for nutrition education	-The evaluation of Autism Eats nutrition education program efficacy and feasibility, in EI setting. -The evaluation of children with ASD dietary intake and disruptive mealtime behaviours.	-3-day food records, to assess the dietary intake -Automated Self-administered 24-Hour Dietary Recall (ASA24®) -Brief Autism Mealtime Behavior Inventory (BAMBI) - Child Feeding Questionnaire (CFQ), to assess parental feeding strategies
Laud et.al., 2009	No		-The evaluation of the possibility an intensive interdisciplinary feeding program would be efficacious for a large group of children with an ASD -The evaluation of intervention's efficacy after intervention's completion -The extension of the given information from previous cases studies and clinical reports, by measuring the treatment outcome of 46 children with ASD assigned to an intensive interdisciplinary feeding program.	- Children's Eating Behavior Inventory (CEBI), for the eating and mealtime challenges. - Questionnaire for caregiver's satisfaction
Sharp et.al., 2019	Yes	-Implemented the intervention to their children -Join group sessions - Was provided opportunities for social comparison -Assigned to Parenting training (PEP) as control condition prior to the intervention -Filled the given scales.	-The evaluation of The Autism MEAL Plan in children with ASD and moderate food selectivity.	- Clinical Global Impression - Improvement Scale CGI-I - Brief Autism Mealtime Behaviors Inventory (BAMBI) - post-treatment 10-item questionnaire, to assess the parental satisfaction

Taner & Andreone 2015	No		-The evaluation of a graduated exposure hierarchy effectiveness for food refusal decrease, food repertoire increase, mealtime behaviours during intervention decrease, and outcome generalization in a young child with ASD -Provide parental training for generalizability and extension of the intervention's positive effect.	Not mentioned

Appendix 5. Description of interventions Continue

Paper	Parental factor included	Description of parent component	Intervention goals	Measures used to analyse the effects
Trewin et.al., 2022	Yes	-Answer survey's questions -They had access to the program and evaluated it	-To inform about the necessity of an online educational program for parents with children with ASD, informing about the impact sensory integration has on feeding. -The examine the consistency MealSense@ and Ayres Sensory Integration@ principles have, according to expert reviewers. -To examine the possibility parents, accept and consider as useful the MealSense@. -To examine the possibility experts, consider MealSense@ included in best feeding practices.	- Survey questions to evaluate program consistency with ASI and best feeding practices, using 4-point Likert scale.
Weber & Gutierrez, 2015	No		-The expansion of available literature on the techniques of sequential and simultaneous presentation procedures, combined with a shaping procedure. -To develop a treatment package which can be used by parents, teachers, and clinicians, with limited prior training,	Not mentioned
Yamane et.al., 2020	No		-To find out diet enhancement in children with ASD, providing prior assessment of their developmental characteristics.	Used in the beginning and end of the support: - Enjoji Developmental Assessment - Kyoto Scale of Psychological Development 2001 Japanese Sensory Inventory Revised (JSI-R)

Appendix 6. Main Results

Studies	Main Results
Bloomfield et.al., 2021	Overall, at the end of the intervention, the participant, consumed 3-10 bites of each of the five-target food. The participants completed or exceeded the demand for 99.35%, 98.73%, 100%, 99.45%, and 100% of the attempts of demand feeding.
Burrell et.al., 2022	Overall, almost half of the participants (47,4%), responded positively to treatment, and for most of them that effect remained. In respect to the disruptive behaviours, the percentage dropped from 77.8% to 11.1% according to the BAMBI scale "cries or screams during mealtimes". For the BAMBI scale "does not remain seated" all children showed improvement.
Congdon 2013	Overall, all the participants showed increase in food acceptance after the intervention. The high-p request enhanced intervention was effective to change the eating behaviour for the two participants. One participant needed Escape prevention and DRA. Participant 1: The average high-p food related request compliance was 99.7% during the baseline. In the enhanced intervention condition with high probability request, the participant had 100% response in food and non- food related requests. During baseline the participant showed 0 acceptance in non-preferred food. When the escape prevention technique occurred, the participant accepted across the 3 session the 50%, 100% and 100% of non-preferred food. During the generalization session the acceptance in non-preferred foods, was 80%. Participant 2: the participant showed various levels of compliance in baseline for high-p food related requests (0% to 100%). In the intervention sessions, the compliance in high-p request was 85.4 and during the final session 90%. During baseline the participant showed 0 acceptance in non-preferred foods. In the last session of high-p food related enhanced intervention, the participant showed 70% acceptance The participant's bite acceptance was 0 at baseline and during the last session of high-p request enhanced intervention was 20%. There were no generalization data. Participant 3: The participant showed 90% to 100% of compliance in most food related request. Only in one the participant had 0 compliance. Across the sessions the participant succeeded 97% in all food related requests. During baseline, the participant showed up to 10 % bite acceptance. During the 7th session of food relate high-p request the bite acceptance were up to 80%.

Appendix 7. Main Results Continued

Studies	Main Results
Gale & Eikeseth, 2010	Participant 1: mean of trials for food acceptance per session before intervention was 0 and after intervention was 16.5 (range 0-20). Mean of trials for disruptive behavior per session before the intervention was 16.3 (range 0-20) and after the intervention was 2.9 (range 0-19). Participant 2: mean of trials for food acceptance per session before intervention was 0.6 (range 0-20) and after intervention was 18.3 (range 0-20). Mean of trials for disruptive behavior per session before the intervention was 19.4 (range 18-20) and after the intervention was 3.0 (range 0-20). Participant 3: mean trials of food acceptance per session before intervention was 0 (range 0-20) and after intervention was 6.2 (range 0-20). Mean of trials for disruptive behavior per session before the intervention was 20 and after the intervention was 11.8 (range 0-20)/ last 4 session 6.25. During the follow up sessions the participants continued to accept foods without demonstrating disruptive behaviors.
Gay, 2022	They will implement statistical analysis to examine the outcomes comparing the baseline scores with the post-treatment scores.
Laud et.al., 2009	There was found significant increase in food acceptance, refusal behaviours and gram consumption and decrease in negative vocalizations. Also, it was found overall decrease in the Total Eating Problem score.

Appendix 8. Main Results Continued

Studies	Main Results
Sharp et.al., 2019	For the feasibility: high parental satisfaction with MEAL Plan program. 94% of parents admit improvement in their child For the efficacy: in the final session 47.4% rated as improved or much improved. The disruptive behaviours decreased. The consumed grams increased For adverse events: 66 out of 67 adverse events were mild or moderate. Only one was serious. Follow up: 15 out of 19 participants had followed- up session.12 participants had the same scores in CGII scale for improvement form base line. 2 participants rated as minimally improved and one as minimally worse.
Tanner & Andreone, 2015	The participant, succeeded to increase his food acceptance from 4 to over 50 foods. 27 of those foods were generalized in different people and environments. The food repertoire also increased. Disruptive behaviours were decreased. The participant generalized quickly food acceptance, but not for foods having similar texture with banana and green papers.
Trewin et.al., 2022	The expert reviewers rated MealSense@ as consistent with ASI. The expert reviewers indicated that intervention's content is related with best feeding practices. Parents rated high the intervention as accepted and useful.
Weber and Gutierrez, 2015	Shaping and sequential presentation procedures can contribute to compliance in eating behaviours. That compliance can be strengthen using shaping and reinforcements. If shaping proved unsuccess, then simultaneously presentation can be used to increase compliance. The use of both of them together can lead compliance to be increased. Reinforcement can lead to increase of food compliance and so can increase eating.
Yamane et.al., 2017	Almost all the children had improved their diet repertoire. The participants without that improvement showed increase in trying new foods. Developmental assessment is a useful tool to select the appropriate strategies.

Appendix 9. Risk of Bias Results

Studies	Bloomfield et.al, 2021	Burrell et. al, 2022	Congdon, 2013	Gale & Eikeseth, 2010	Gray et. al, 2022	Laud et. al, 2009	Sharp et. al, 2019	Taner & Andreone 2015	Trewin et. al, 2022	Weber & Gutierrez 2015	Yamane et. al, 2020
Representativeness of sample	No	No	No	No	Yes	Yes	No	No	No	Na	No
Control group use / Comparison of intervention and control groups/ Appropriate randomization	Na, na	Na, na	Na, na	No, na	Yes, yes	No, na	Yes, yes	Na	No	No, na	No
Quality of the outcome measure/ valid measure / reliable measure/ possible measurement reproduction	No, no, yes	Yes, yes, yes	No, no, no	Yes, yes, yes	Yes, yes, yes	Yes, yes, no	Yes, yes, yes	No, no, no	Yes, yes, no	Yes, yes, yes	No, no, yes
Quality of the intervention description / techniques clarity / possible intervention reproduction	Yes, yes	No, no	Yes, no	Yes, yes	No, no	No, no	Yes, yes	Yes, yes	No, no	Yes, yes	Yes, yes
Missing data / description / bias avoidance	No, na	No, no	No, na	No, na	Yes, yes	No, no	No, no	Na, na	No, na	No, na	No, na
Use of appropriate statistical tests	Na	Yes	Na	Na	Yes	Yes	Yes	Na	Yes	No	No
Deviations from the intended interventions /successful intervention implementation / participants adhere to the assigned intervention regimen	Yes, yes	Yes, yes	Yes, na	Yes, yes	Na, na	Yes, yes	Yes, yes	Yes, yes	Na, na	Na, na	Yes, na