Avoidant/restrictive food intake disorder (ARFID) and severe food selectivity in autistic children and young people: A scoping review

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Abbreviations:
ARFID - Avoidant/restrictive food intake disorder
ASD - Autism spectrum disorder
CYP - Children and young people
DSM-5 - Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
RCTs - Randomised controlled trials

Abstract

Aim: This review aimed to assess the extent of the scientific literature on ARFID in autistic children and young people (CYP) in order to evaluate and synthesise the evidence on: (1) the nature of feeding and eating difficulties in autistic CYP, (2) the consequences of a severely restricted diet, and (3) what is known about effective treatment approaches.

Method: PubMed and PsycInfo databases were searched, identifying fifty-five studies, and a narrative synthesis was effected.

Results: The literature suggested that ARFID-like presentations are common in autistic CYP, with severe consequences for physical and mental health. All three drivers, as per the DSM-5 criteria, are present in this population, although sensory sensitivities are currently the most commonly described. Research suggests that ARFID symptoms in autistic CYP can be amenable to treatment, with evidence that behavioural interventions are feasible and potentially effective in this population.

Interpretation: ARFID is a common and impactful problem amongst autistic young people but is currently under researched. Work is required to: (1) identify the prevalence of ARFID in autistic CYP; (2) uncover the key drivers of ARFID in this population; (3) adapt currently available interventions for use with autistic CYP; (4) rigorously test these interventions in clinical trials.

Keywords:

Autism spectrum disorder, ARFID, severe food restriction, children.

What this paper adds:

1. Significant food restriction is common in autistic children and young people
2. Sensory sensitivities are frequently cited as a reason for food restriction
3. There is a considerable need for more research in this domain

Feeding and eating difficulties are commonly reported in early childhood. These may include, but are not limited to, a fear of or reluctance to try new foods (food neophobia), food sensory issues, food selectivity or fussiness, reduced appetite, challenging or problematic mealtime behaviours and repetitive or rigid food preferences[1-3]. Although widely accepted as a passing phase of development which peaks in early childhood[4-7], continued or severe disturbances in eating can represent a clinically significant concern.

Avoidant restrictive food intake disorder, or ARFID, first emerged as a diagnostic category in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)[8] and more recently in the 11th Revision of the World Health Organisation's International Classification for Diseases (ICD-11)[9]. ARFID was introduced to describe clinically significant restrictive eating behaviours which are not driven by body image disturbances or fears of weight gain and covers a heterogeneous group of patients across the lifespan who limit food intake, whether by type, amount or both. Such behaviours can be driven and maintained by a number of factors, and work is still underway to fully understand the varied aetiology of ARFID[10]. Nevertheless, the original DSM-5 diagnostic criteria acknowledge three features which have been frequently observed in clinical practice and serve to represent examples that may drive the avoidance/restriction, namely: (1) an apparent lack of interest in eating; (2) an avoidance based on the sensory characteristics of food; and/or (3) a concern about the aversive consequences of eating[8].

The persistent disturbances in eating that are the core feature of ARFID can result in a number of clinical manifestations, the most common of which are considerable weight loss (or faltering growth in children), marked nutritional deficiencies, dependence on oral nutritional supplements and/or reliance on enteral feeding. Physical consequences aside, ARFID can also have a significant impact on psychosocial functioning, for example, if an individual is isolated

as a result of their inability to engage in social mealtimes or if eating difficulties interfere with their ability to foster or sustain close relationships[8].

Autism spectrum disorder (henceforth, autism) is a neurodevelopmental condition associated with restricted, repetitive or stereotyped behaviours or interests, as well as impairments in social communication and social reciprocity[8]. The characteristic pattern of behaviours, needs and sensitivities associated with autism can give rise to a limited food repertoire, specific sensory preferences and rigid rules regarding mealtimes. This can result in substantial limitations relating to the type and/or amount of food consumed[11-13]. As a result, autistic children and young people (CYP) may be at an increased risk of ARFID compared to those who are not autistic[14-16].

Evidence suggests that autistic individuals are at a heightened risk of long-term physical health conditions and premature mortality[17-19], but the reasons for this remain unclear. One study[20] found that autistic adults are less likely than non-autistic adults to meet minimal recommendations for diet, exercise and sleep. Indeed, feeding problems and dietary restriction affect nutrition and as such, may be an important contributing factor in health status.

Currently, very little is known about the course, development, management and outcomes for those with co-occurring ARFID and autism. ARFID research, and in particular, the literature regarding ARFID in the autistic population, is still limited. Several studies have reviewed eating disorders, food selectivity and disordered eating behaviours in the autistic population[21-23]. One study was found to review the presence and management of scurvy in autistic children as a result of severe food selectivity consistent with ARFID[24] and another qualitative systematic review reported on nutritional deficiency diseases in the autistic population as a result of ARFID[25]. To our knowledge, however, this is the first review to assess the current status of available evidence in relation to ARFID in autistic CYP. In particular, we aim to address the following questions:

- What is the reported nature of feeding and eating difficulties in autistic CYP with ARFID/significant food restriction?
- What is known about the consequences of a severely restricted diet in this population?
- What is known about effective treatment approaches for ARFID/significant food restriction in autistic CYP?

Method

This review was conducted in line with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)[26]. Scoping reviews are an approach to knowledge synthesis that are useful for addressing broad questions as they map the extent and nature of available research[27]. Such reviews are particularly useful when the need for information on a particular topic is time sensitive as they streamline the systematic review process, but nevertheless possess the key features of a systematic review, ensuring rigour, transparency and replicability. These include: (1) a prespecified question; (2) the use of an electronic search; (3) defined inclusion and exclusion criteria; (4) the selection of studies based on the inclusion criteria; (5) the extraction of data; and (6) the interpretation and presentation of the results. As such, the findings can be used to aid planning of future research and inform policy decisions.

We completed this review in partnership with Autistica, the UK's national autism research charity, in response to a request from NHS England and leading charities in the field for an evidence summary which would feed into policy development. Specifically, we were asked to review and synthesise the published literature addressing the overarching review question: Avoidant restrictive food intake disorder (ARFID) and autism: What is currently known?

Literature search

Searches were conducted in PubMed and PsycInfo on 27th January 2020 and updated just prior to analysis on 3rd March 2021. We employed keywords relating to ARFID and autism in order to capture studies with a clear focus on feeding or eating difficulties in autistic CYP (see Tables 1 and 2 for search terms).

Since very few studies have reported on those with concurrent diagnoses of ARFID and autism, we chose to also include all studies which describe autistic CYP with severe feeding and eating difficulties that would likely confer a clinical diagnosis of ARFID if assessed against the diagnostic criteria. Specifically, we selected only those studies that expressly described at least one participant with a diagnosis of autism as well as one or more of the following (in accordance with ARFID DSM-5 diagnostic criteria):

- Individuals experiencing significant weight loss, faltering growth or persistent failure to achieve expected weight (in the absence of any body weight or shape disturbances)
- Individuals with a significant nutritional deficiency
- Individuals experiencing marked difficulties in psychosocial functioning as a result of a restricted diet

Eligibility criteria

The following studies were eligible for inclusion in this review:

- Full text English language journal articles with human participants published after 1994 (to ensure autism diagnoses did not predate the DSM-IV diagnostic criteria)
- Studies involving children and young people under the age of 18 with a concurrent diagnosis of Autism Spectrum Disorder/Asperger's/Pervasive Developmental Disorder and ARFID (or participant(s) displaying food avoidance, restriction or selectivity which would meet criteria for ARFID)

Study selection and data extraction

One reviewer (L.B) conducted the search, screening and selection process. Following the removal of 26 duplicates, a primary inspection of study titles and abstracts was conducted, and book chapters, conference proceedings, editorials, dissertation abstracts, theses and review articles (including meta-analyses) were removed. Following this initial screen, full text articles of the remaining studies were retrieved and assessed against eligibility criteria (see Figure. 1). Records were then independently reviewed by two experts in the field (R.B.W and W.M) and all reviewers met to resolve any conflicts and to ensure that selected papers were in line with the aims of the review.

Results

The search yielded fifty-five studies, the majority of which were case studies or case series (n = 37/55, 67%). Participants ranged in age from 3 years to 20 years, and studies were conducted worldwide, from the UK to Australia, although the majority were from the USA (n=43/55, 78%). Just two of the papers reported specifically on those with a concurrent diagnosis of ARFID and autism[28, 29]. Thus, the majority of the literature discussed in this review describes participants with significant disturbances in feeding and/or eating, which closely mirror the symptoms of ARFID as defined by the DSM-5 criteria[8].

What is the reported nature of feeding and eating difficulties in autistic CYP with ARFID/significant food restriction?

Although the literature on autistic CYP reliably evidences the three main reasons of food avoidance and restriction in ARFID, as per the original diagnostic guidelines[8], sensory sensitivities are currently the most cited. This is perhaps unsurprising given the atypical sensory processing associated with autism[30-32]. Aversion to texture is the most commonly reported concern[33-42], although sensitivity to taste, temperature, type, colour, and appearance have also been described[33,34,36-38,41,43-45]. This has been shown to result in gagging, spitting, vomiting, self-injury and aggression[44,46-48]. Such preferences tend to give rise to a very limited diet,

consisting of bland, starchy and 'beige' foods, such as crackers, potatoes, rice and bread products[37,49].

The second example ARFID presentation, a fear or phobia-based avoidance or restriction of intake, has also been evidenced amongst autistic young people, with anxieties relating to swallowing[50], contamination[6], fears of trying new foods[46] and choking preceded by a traumatic event[51].

Just one definitive case of a lack of interest in eating is reported[6] but other studies do describe participants who engage in slow eating[52] and have difficulty sitting at the table for a full meal[53], both of which may be driven by low interest in food or eating.

Finally, certain thinking styles appear to co-occur with disturbed eating patterns in autistic young people. For example, a preference for routine, cognitive rigidity and/or intolerance of uncertainty can manifest as a reluctance to participate in social mealtimes[54], a preference for the use of the same vessel, container or cutlery[28,44,55,56] or insistence on the consumption of a particular brand of food or drink[33,38,41,43,53,54,56,57].

What is known about the consequences of a severely restricted diet in this population?

There is reliable evidence to suggest that ARFID and severe food restriction in autistic CYP is associated with a greater risk of poor health outcomes[56,58,59,60-62].

Arguably the most observable consequence of a severely restricted diet is low weight or significant weight loss, which in children, tends to manifest as a persistent inability to meet expected growth or developmental expectations[38,50,51,63,64]. Despite this, ARFID does not always correspond to low weight. The literature also evidences CYP who are overweight as a result of the consumption of a narrow range of energy-dense foods or those high in fat, sugar or salt[52,54].

Body weight considerations aside, poor dietary variety can also lead to nutritional deficiencies. The literature on autistic CYP with severe food restriction reports a number of health issues stemming from the lack or absence of certain micronutrients, including jaundice, anaemia, scurvy, rickets, gingivitis and hypogonadism[37,56,58,61,62,65,66].

Aside from the obvious consequences of malnutrition, a number of additional serious health concerns have also been cited in this population. These include chronic constipation, ulcers, visual impairment as a result of Vitamin A and B_{12} deficiencies, arthritis, laboured breathing, movement difficulties and liver dysfunction[37,49,53,59,67-69]. For those not getting enough food to meet caloric or nutritional needs, oral nutritional supplements can be a useful way to ensure the adequate intake of macro- and micronutrients[36,39,70]. It is important to note, however, that these are not always readily accepted by autistic CYP due to sensory preferences and sensitivities. Extreme cases may require enteral feeding via the alimentary canal (e.g., nasogastric, percutaneous endoscopic gastrostomy) or, more rarely, parenteral feeding, which is typically intravenous, may be required to deliver nutritional support[34,59,71,72].

ARFID can also markedly impair psychosocial functioning if the individual can only tolerate eating alone and avoids social situations where food is served. This can lead to difficulty integrating at school or in the workplace and often results in social isolation[50,54]. This is of particular significance for autistic CYP who are already at a higher risk of social exclusion due to differences in communication and cognitive processing as well as difficulties understanding interactions and social expectations. The added challenge of eating non-preferred or feared foods is likely to cause significant distress during social mealtimes.

What is known about effective treatment approaches for ARFID/significant food restriction in autistic CYP?

A multidisciplinary approach is commonly evidenced as an effective way to assess and manage those with autism and severe food restriction[6,35,43,51]. This involves intensive and often

continued input from a number or combination of services and clinicians, including speech and language therapists, autism services, dietitians, local social networks and mental health day services.

The primary objective is to recognise and target what is driving the eating difficulty in the autistic CYP. Various behavioural interventions, including backward chaining, stimulus fading procedures, repeated taste exposure, escape extinction and positive reinforcement interventions have been reported to improve intake and diminish the impact of limited intake for autistic CYP displaying severe food selectivity, sensory dysfunction, and food and liquid refusal[38,47,48,70,73-78]. It is worth noting, however, that the majority of the studies presenting success with behavioural interventions are case studies with few participants, often just one or two. Whilst such studies provide a rich and in-depth source of information, the basis for generalisation is limited.

For those with serious physical concerns, medical input may be necessary. Various studies report on the medical management of autistic CYP with severe food restriction, including enteral or parenteral nutrition to increase weight[56,64] as well as intravenous or oral nutritional supplementation to treat severe malnutrition[37,56,59,61,66-69].

Finally, the literature on autistic CYP with severe food restriction evidences eight case studies, one pilot trial, one randomised controlled trial (RCT) and one retrospective chart review reporting on family-centred or caregiver/teacher-led interventions used to treat food avoidance, increase consumption and tackle challenging mealtime behaviours[33,41,46,48,53,54,57,77-80]. The findings appear to support family/parent-led approaches, with reported increases in dietary diversity, food acceptance and participation in meal and snack times observed, as well as reduced parental anxiety and increased family quality of life.

Discussion

This scoping review aimed to assess the current state of available evidence relating to ARFID in autistic CYP. Despite a growing body of literature relating to ARFID in clinical and general populations, there is a paucity of research relating to co-occurring ARFID and autism. Just two studies reported on formally diagnosed ARFID in the autistic population[28,29]. Consequently, we chose to extend the inclusion parameters to accept literature on autistic CYP with severe food selectivity or restriction consistent with ARFID. In total, fifty-five studies were eligible for inclusion.

Despite the lack of literature relating directly to ARFID and ASD, our review shows that this is likely to be a highly prevalent and impactful problem amongst autistic children. The literature evidences the presence of all three of the main drivers of food avoidance and restriction mentioned in the original diagnostic guidelines[8], although sensory sensitivities are currently the most commonly described in autistic CYP. These features are not mutually exclusive, however, and studies with non-autistic CYP have evidenced ARFID presentations with multiple drivers of food avoidance and/or restriction[81,82]. Further work is needed to explore other presentations of ARFID, including a lack of interest in eating and anxiety related avoidance, and basic epidemiological studies are needed to provide data on the prevalence of ARFID and main drivers of food avoidance in the autistic population.

In terms of treatment, most studies trial behavioural techniques used to tackle standard food selectivity or avoidance (e.g., picky/fussy eating). While there are no ARFID/ASD specific treatment interventions, several case studies have demonstrated the success of core ARFID treatments, particularly behavioural interventions, in a non-autistic population[83-85], which may be implementable and effective with autistic CYP. In particular, preliminary evidence has supported cognitive behavioural therapy for ARFID (CBT-AR) as an effective treatment for heterogeneous presentations of ARFID in children, adolescents and adults[86-88].

Importantly, however, this is yet to be fully trialled with an autistic population. Since difficulties with feeding and eating in autistic CYP can be further compounded by sensory sensitivities, idiosyncratic behaviours, social anxieties and difficulties with communication[12,45,89], individual requirements should be taken into consideration and adaptations made to facilitate access to interventions for autistic CYP.

Current national and international guidelines advocate the use of psycho-behavioural therapy, typically on an outpatient basis, for all eating disorders, including ARFID, as well as treatment which addresses important nutritional, physical and mental health comorbidities[90]. Further to this, the National Institute for Health and Care Excellence[91] make several recommendations when treating an individual with an eating disorder as well as a comorbid mental health condition. Clinicians are advised to consider the severity and complexity of the eating difficulty and the comorbidity, the person's level of functioning, and the preferences of the person with the eating disorder, as well as their family or carers if appropriate.

There is a particular dearth of research relating to the measurement of ARFID behaviours. No studies were found to report on tools used to diagnose ARFID or to assess symptomatology in the autistic population, although work is currently underway to design and validate reliable screening and diagnostic instruments in non-autistic cohorts[92-94]. As above, it is likely the case that existing ARFID measurement tools are appropriate but that reasonable adjustments are needed to accommodate particular sensitivities or preferences and to ensure best fit.

This study has several limitations. First, we restricted our inclusion criteria to only those studies from English language journals. Non-English language publications, as well as dissertations, conference proceedings and book chapters may have provided a valuable insight into the topic. Secondly, we chose to extend the parameters of our search to include autistic CYP with severe feeding or eating difficulties that may have met the diagnostic criteria for ARFID. This process was subjective and based on an examination of the description of

symptoms provided by the study authors. As such, it is not possible to be sure that every participant included in each study for this review would receive a diagnosis of ARFID.

In summary, this review highlights a clear need for further research on ARFID in autistic CYP. Despite substantial literature on food selectivity and feeding problems in autism (food refusal, limited food repertoire, high frequency single food intake, disruptive mealtime behaviours, oral motor delays), few studies to date have focused exclusively on the presence of ARFID in the autistic population. Much of our current understanding of ARFID is based on case reports or cross-sectional studies which are limited by small sample sizes and tend to represent the most notable or extreme examples. While these are useful, we will need randomised controlled trials over the coming years if we are to build a solid evidence base. Epidemiological studies are needed to establish the extent and nature of severe food selectivity and experimental work is needed to understand the mechanisms which underlie such issues. This can lead to the selection and adaptation of pre-existing interventions that have proved successful, which in turn can give way to RCTs to establish effective ARFID treatments for autistic CYP. In the longer term, such work may provide an insight into the contributing role of nutrition in poorer health outcomes for autistic individuals.

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Author Contributions

- Laura Bourne conducted the literature search and led the data analysis, interpretation of findings and manuscript writing.
- Professor Mandy contributed to the study design, analysis of the results and the writing of the manuscript.
- Dr Bryant-Waugh contributed to the study design, analysis of the results and the writing of the manuscript.
- All authors have approved the final manuscript as submitted and agree to be accountable for all aspects for the work.

Conflict of interest disclosure

The authors have no conflicts of interest relevant to this article to disclose.

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Table 1. Search Terms and Results from PsycInfo Search

1. Autism	2. Eating disorder
autism.ti. OR autism.ab. OR pervasive developmental disorder*.ti. OR pervasive developmental disorder*.ab. OR Asperger*.ti. OR Asperger*.ab.	ARFID.ti. OR ARFID.ab. OR avoidant restrictive food intake disorder.ti. OR avoidant restrictive food intake disorder.ab. OR feeding.ti. OR feeding.ab. OR eating.ti. OR eating.ab.
1: 3,519	2: 5,420
1 AND 2: 47	

Table 2. Search Terms and Results from PubMed Search

1. Autism	2. Eating disorder
Autism[tiab] OR autistic[tiab] OR pervasive developmental disorder*[tiab] OR Asperger*[tiab]	ARFID[tiab] OR avoidant restrictive food intake disorder[tiab] OR feeding[tiab] OR eating[tiab]
1: 30,779	2: 92,646
1 AND 2: 502	

*[tiab] Words and numbers included in a citation's title, collection title, abstract, other abstract and keywords.

Table 3. Summary of Articles Relating to ARFID and Severe Food Selectivity in Autistic CYP

	Author(s) and year	Study aims	Study design and sample	Feeding/eating concerns and consequences	Main findings/outcomes
1	Hagopian et al. (1996)	To describe the feeding concerns and subsequent treatment of a patient with total food and liquid refusal	Case study 12-year-old autistic male	• Total food and liquid refusal and NG tube dependency • Medical history of life-threatening GI conditions • Admitted to inpatient unit • Frequent emesis resulting in total parenteral nutrition	• Backward chaining, fading and reinforcement used to increase liquid consumption
2	Freeman and Piazza (1998)	To report a patient with food refusal and destructive behaviour	Case study 6-year-old autistic female	• 4-year history of food refusal • Severe weight loss and dehydration • Occasionally consumed food that had been left out if others were not present • Aggression and self-injurious behaviour when required to eat	• Treated using stimulus fading, reinforcement and escape extinction • Intake increased and patient consuming 50% of age-appropriate meal
3	Dellatan (2003)	To describe the use of a music intervention of a 5-year-old male with chronic food refusal	Case study 5-year-old male with a diagnosis of PDD and autism	• Diagnosed with failure to thrive at 13.5 months • Oral food aversion • Dependence on NG tube (1-8 months) followed by a gastrostomy tube	• Significant decrease in food refusal behaviours • Increase in the quantity of food consumed
4	Luiselli et al. (2005)	To describe a liquid fading procedure used to increase consumption of milk	Case study 4-year-old autistic female	• Food selectivity and limited food repertoire (3 foods and fruit juice) • Reliance on oral nutritional supplement (Pediasure/50% whole milk)	• Taught to drink milk through a liquid fading procedure • Concentration of milk mixed with Pediasure gradually increased until at 100%
5	Uyanik et al. (2006)	To present the case of a child with autism and significant malnutrition resulting in xerophthalmia	Case study 8-year-old autistic male with epilepsy	• Very limited diet – fried potatoes and water • Vitamin A deficiency • Progressive visual impairment (unable to open eyes for the last 4 months)	• Treated with antibiotic drop therapy and intramuscular and oral multivitamin supplementation (including vitamin A palmitate) • Ophthalmic examination 1-month post-treatment showed prominent corneal improvement, patient was able to open his eyes and had regained some of his vision
6	Gravestock et al. (2007)	To describe the management of a man with Asperger's disorder, a chromosomal condition, and food refusal	Case study 20-year-old male with Asperger's disorder and XYY syndrome BMI 17.1 kg/m^2	• Choking episode at 19 years, triggering marked anxiety with eating and swallowing • Liquid food supplements given • Solid food refusal and 6kg weight loss in 3 months	• Intervention from speech and language therapist to re-introduce wider range of fluids and semi-solid foods, as well as individual CBT • Patient also given access to dietetic and mental health day services, advice from local social and employment support network and autism services

					• Patient more willing to eat preferred semi-solid foods and liquids and gradually gained weight over the next year (BMI 19.6) • Anxiety about swallowing and choking still significant and patient still reliant on Fortisip food supplements several times a day
7	Noble et al. (2007)	To describe the presentation and treatment of a child with severe nutritional deficiency and medical concerns as a result of severe food selectivity	Case study 5-year-old male with PDD, BMI 13.6 kg/m^2 (height 25th percentile, weight < 5th percentile) (Case 2 featured but no diagnosis of autism or PDD)	• Progressively restricted diet. By 3½ years, diet consisted largely of crackers, ice cream and water • Vitamin C level undetectable and diagnosis of scurvy given	• Patient hospitalised and gastrostomy tube placed for adequate caloric and vitamin intake • Vitamin C supplementation resulted in improved range of motion in legs, behaviour and pain control • 2 months later - patient gained 12lbs and returned to school • 6 months later - 20lb weight gain
8	Paul et al. (2007)	To describe an intervention combining repeated taste exposure and escape prevention to treat two cases of food selectivity and refusal	Case study (1) 3½-year-old autistic male (2) 5-year-old autistic female	(1) Very limited diet (milk, grilled cheese sandwiches, hot dogs). Aggressive and disruptive mealtime behaviours and food refusal (2) Complete food refusal since acute illness 6 months ago (although diet was limited beforehand). Now completely dependent on gastrostomy tube	(1) Acceptance of 65 foods after 15 days of intensive treatment (2) Gastrostomy tube no longer required and 49 foods accepted after 13 days of intensive treatment
9	Casey et al. (2008)	To describe chronic food refusal in a child with autism	Case study 8-year-old autistic male Below 5th percentile for weight and height	• History of food aversion and total food refusal • Lack of sufficient caloric intake to meet normal growth standards (diagnosed with failure to thrive) • Gastrostomy tube in place for four years	• Following behavioural intervention, total bite acceptance varied but was consistently above baseline levels • Weight increased (between 5th and 10th percentile) • G-tube removed
10	Keen (2008)	To describe the association between significant feeding difficulties and early onset failure to thrive	Case study 7 autistic patients (6 male, 1 female) Sample from a clinic population	• Severe feeding problems including refusal of solids, contamination fears, disinterest/absence of enjoyment, vomiting • Significant failure to thrive (fall across two major weight centile lines and BMI below the 0.4th centile in all cases) • Three children required enteral feeding (nasogastric/gastrostomy)	• Intensive, multimodal intervention to tackle dysfunctional sensory processing, attachment, cognitive inflexibility and learnt behaviours, and anxiety/phobia • The presence of severe and persistent feeding problems/failure to thrive in young children may indicate clinicians to the possibility of autism

11	Stewart and Latif (2008)	To describe the clinical characteristics and consequences of a severely restricted diet in a patient with autism	Case study 15-year-old autistic male (below the 0.3rd centile for height and weight)	• Poor diet since infancy (mainly chips and gravy, complete refusal of dairy) • Complaints of tiredness and muscular weakness • Reluctant to leave the house (minimal exposure to sunlight) • Diagnosis of vitamin D deficient rickets and hypogonadism	• Referrals made to a local dietician and regional endocrine team • Calcium supplements and multivitamins given • 6 months later - asymptomatic with no muscle pain and good mobility, most abnormal blood parameters had normalised, beginning to catch up on growth • Meat and dairy products accepted into diet
12	Williams et al. (2008)	To examine parent feeding practices and their relationship to the weight status, diet variety and mealtime behaviours for a group of children with problematic eating/feeding	n = 240 (n = 75 with autism, n = 85 with other special needs, n = 80 typically developing)	• Feeding problems experienced by children in the sample included: Food refusal; selectivity by texture; selectivity of type (narrow range, nutritionally inadequate) • The consequences of such problems were: Children not getting enough food to meet caloric or nutritional needs; weight to height ratio below 5th percentile; unable to maintain appropriate growth	• Multiple regression analyses found that age and diagnosis of autism were found to be significant predictors of weight status • Autistic children tended to exhibit less diet variety, with significantly fewer foods consumed compared to other children (consisting mainly of dairy products and starches)
13	Binnendyk and Lucyshyn (2009)	To evaluate the effectiveness of a family-centred positive behaviour support approach to manage food refusal behaviour	Case study 6-year-old autistic male	• Limited diet consisting of soda crackers, rice, water, donuts and cookies • Refusal to try new foods, with attempts ending in throwing, spitting, vomiting, self-injury and aggression • Reliance on four cans of Pediasure each day	• Parent-led intervention used (following training and support) • High levels of food acceptance, mealtime behaviour improvements observed (sitting at the table alone, using utensils with minimal assistance) and family quality of life • Mealtime behaviours improved • Progress maintained up to 26 months post-intervention
14	Laud et al. (2009)	To evaluate treatment outcomes for an interdisciplinary feeding programme for child with challenging feeding behaviours	Retrospective chart analysis 46 autistic children (6 female, 40 male), mean age 69 months	• Various concerns including food refusal, limited variety of foods consumed, food selectivity by texture, failure to thrive	• Intensive interdisciplinary treatment programme involving a gastroenterologist, paediatrician, nurse practitioner and nutritionist • Significant improvement in feeding behaviours observed and maintained at follow-up
15	Sharp and Jaquess (2009)	To describe a treatment intervention used to increase volume and texture of food consumed by a child with severe food selectivity	Case study 3-year-old autistic male	• Severe food selectivity and food refusal • Diet consisting primarily of Pediasure delivered with a bulb syringe • Occasional acceptance of pureed bananas (stage 1 baby food) presented on a spoon	• Admittance to a day-treatment programme • Four 30-45 min therapeutic meals conducted each day by a trained therapist • Rapid acceptance of all bite sizes (although some gagging occurred with larger bites in the early stages of presentation) • Rapid acceptance of all textures, but some expulsions and gags with higher textures

					• By 12th day of treatment, caloric intake was sufficient to discontinue syringe feeds
16	Hendy et al. (2010)	To evaluate parent mealtime actions and their association with children's fussy eating	236 children (50 autistic, 84 with other special needs and 102 without special needs) 153 males, 83 females, mean age = 58.3 months	• Food fussiness, little variety • Parent providing 'special meals' separate to that given to family (consisting of child's favourite foods) • Underweight with BMI% less than 10 (10% of autistic children in current sample) • Reliance on nutritional supplement drinks	• One parent mealtime actions (special meals) was found to explain variance in children's BMI% and diet variety • Although preparation of special meals may improve BMI% and increase weight, it may also exacerbate rigid eating behaviours/food selectivity practices
17	Pineles et al. (2010)	To describe three cases of vision loss and optic atrophy as a result of vitamin B12 deficiency relating to poor diet in autistic children	Case series (1) 6-year-old autistic male (2) 13-year-old autistic male (3) 7-year-old autistic male	(1) Diet consisting primarily of bagels, cereal and French fries; 1-month history of decreased visual acuity (2) Diet consisting primarily of potatoes, fruit and bagels; gradual vision loss over 6-months (3) Diet consisting primarily of French fries and chicken nuggets; changing visual behaviour; recent difficulty navigating familiar areas;	• Visual behaviour improved in all three cases after beginning B12 supplementation
18	Roth et al. (2010)	To describe a multicomponent behavioural intervention used to manage severe food selectivity in an adolescent	Case study 16-year-old male with Asperger's disorder Height and weight - 3rd percentile	• Very selective eater at 4 years of age and began to refuse most food at 5 years of age • Lack of weight gain, poor growth • Dependence on gastrostomy tube for 9 years • Selectivity by type and texture - only water and 3 brand specific foods consumed (bowtie pasta, ham steak, and cereal)	• Intervention consisted of several components, including stimulus fading for solids and liquids, a token economy for solids, and an escape prevention component for liquids • Need for gastrostomy tube feeds eliminated • 78 foods and 13 drinks accepted • Treatment gains maintained 3 months post-intervention
19	Seiverling et al. (2011)	To evaluate the 23-item Screening Tool for Feeding Problems with a sample of children referred to a hospital-based feeding clinic	n = 142 children (47 female, 95 male), mean age = 61.4 months n = 43 with autism, n = 51 with other special needs, n = 48 with no special needs	• Various feeding problems including food selectivity (type, texture, temperature), food refusal and vomiting • 33 children (27%) underweight with BMI less than 10th percentile	• Factor analysis revealed a more psychometrically sound 15-item version of the original 23-item STEP (Matson & Kuhn, 2001) • Mediation analysis found that "overly permissive" actions by parents explained over 34% of the links between children's feeding problems and poor weight and diet outcomes
20	Seiverling et al. (2011)	To develop a simple measure of Texture Problems relating to feeding difficulties and to identify child and parent variables associated with increased risk for Texture Problems	n = 248 children from a hospital feeding clinic (85 female, 163 male) mean age = 48.9 months n = 50 with autism, n = 96 with other special needs, n = 102 with no special needs	• Various feeding problems including food refusal, limited food repertoire, texture problems, reliance on enteral feeding, underweight	• Parents completed questionnaires to report their children's demographic and medical information, feeding issues and parent's mealtime actions • Difficulties with food texture was associated with younger age, males, and prematurity

21	Sharp et al. (2011)	To examine the nutritional status and mealtime behaviours of a group of children following an intensive feeding day-treatment programme	Retrospective chart review n = 13 children (2 female, 11 male) with a diagnosis of autism (i.e., autistic disorder, PDD-NOS) Age range: 2 years, 11 months to 7 years, 8 months (mean: 4 years, 5 months)	• Severely restricted diets, low rates of acceptance and swallowing, high rates of disruptive mealtime behaviours • Two children fell below the 3rd weight for height percentile	• Treatment involved escape extinction, reinforcement and stimulus fading procedure • Significant improvements observed in food variety, consumption and appropriate mealtime behaviours • Caregiver training administered which maintained treatment gains
22	Tang et al. (2011)	To describe two cases of severe food selectivity and feeding problems	Case series (1) 10-year-old autistic female (2) 3-year-old autistic male	(1) Stopped drinking and food choices had become increasingly restrictive. Severe constipation, severe malnutrition, 20lbs weight loss over 4 months (2) Lethargy and general edema for 6 weeks. 2-year history of restrictive diet (pureed fruit and coconut juice) and refusal to eat anything but a specific brand in a certain container while holding his favourite blanket. Thin, scaly rash throughout body, hair thinning, anaemia, hypoalbuminemia and hypoproteinaemia	(1) Admittance to hospital. Nasogastric tube placed which helped to increase weight from 68% to 75% (ideal body weight) but refusal to eat persisted. Behaviour modification plan implemented and small portions of food were accepted (2) Admittance to hospital. Nutritional formula feedings administered via nasogastric tube. Weight gain was adequate and nutritional deficiencies became normal. Behavioural modification programme implemented to overcome severe food aversion
23	Knapp et al. (2012)	To describe the implementation of a behavioural intervention to tackle severe food refusal and mealtime problem behaviours	Case study 16-year-old female with PDD-NOS	• Food refusal and mealtime problem behaviours including expulsion, head turning and batting at presented food • Patient would not swallow food, instead holding it in her mouth for an extended period of time • Interference with social activities (i.e., eating a meal out with her family) • Severely underweight	• Positive reinforcement intervention conducted in the lunchroom at school during scheduled meal times • Clinically significant reduction in problem behaviours observed and increase in acceptance and swallowing of food • Results were maintained at follow-up and the patient successfully ate lunch in various social settings
24	Knox et al. (2012)	To describe a teacher-led intervention used to treat an adolescent girl with chronic food selectivity	Case study 16-year-old autistic female	• Diet consisting primarily of “crunchy” foods (brand crackers, dry cereal and apple juice) • Underweight for her age	• Paced-prompting, differential positive reinforcement and demand facing used in a natural setting (participant’s school) to increase the quantity of novel foods consumed • Participant consumed 100% of her meals and exhibited no problem behaviours • At 7-month follow-up, improved consumption was maintained
25	Rogers et al. (2012)	To explore mothers’ perspectives of managing the challenges of a child with autism and severe feeding/eating difficulties	Qualitative interviews 11 mothers (aged 28-47 years) 12 children with autism or Asperger’s syndrome aged	• Severe food selectivity “more than just picky eating” • Food refusal, restricted and narrowing food repertoire in at least one food group (many in two or three)	• Four feeding processes emerged from the analysis: (1) recognising the feeding challenges, (2) defining the underlying nature of the feeding challenges, (3) seeking support for and validation

			from 4-10 years (11 male, 1 female)	• Sensory aversion, gagging, need for sameness (brands, taste, presentation, vessel) • Reliance on Pediasure for nutrition • Underweight, not following growth curve	• of the feeding challenges, and (4) staging their approach • When feeding problems extend beyond mere picky eating, parents need support from professionals who validate their concerns
26	Berube et al. (2013)	To describe a patient with experiencing severe physical symptoms as a result of chronic vitamin C deficiency	Case study 11-year-old autistic female	• Diet very restricted for first several years of life (banana, yoghurt, milk, apple juice) • Several foods added as patient grew up, but diet still very restricted by sensory sensitivities • At 11 years, patient experienced difficulty walking, developed extensive bruising over her legs and gingivitis	• Clinicians assessed the patient and suspected that symptoms may be due to severe vitamin C deficiency as a result of her very limited diet • Liquid multivitamin supplement given and consultation with feeding team to implement strategies to broaden food choices and increase vitamin C in diet • Twenty days after hospital discharge, the patient's symptoms had completely resolved
27	Duvall et al. (2013)	To report a case of severe vitamin malnutrition as a result of a limited diet	Case study 9-year-old autistic male	• Limited diet consisting mainly of white foods. Refusal of milk, juice, vegetables, fruit and not taking any vitamin supplements • Development of a limp which continued to worsen until he was unable to move around, as well as laboured breathing • Tests revealed deficiencies in vitamins C, B1, B6, D (scurvy)	• Hospital admittance • Repletion of vitamin deficiencies via intravenous muscular injections • Respiratory rate returned to normal range and patient able to walk without pain • Patient discharged from hospital after 3 weeks to continue oral supplementation
28	Gongidi et al. (2013)	To report a case of a child with scurvy as a result of severe nutritional deficiencies	Case study 5-year-old autistic male	• Food-avoidant behaviours resulting in nutritional deficiencies • Development of abnormal gait with inward turning feet as well as leg and back pain • Other symptoms included gingival swelling, tenderness and swelling of wrists and multiple scabs and abrasions • MRI scans revealed abnormalities, leading to a diagnosis of scurvy	• Hospital admittance • Repletion of Vitamin C which resulted in amelioration of symptoms and subsequent discharge
29	Kadey et al. (2013)	To describe the use of a Nuk brush to increase acceptance of foods and liquids in two children with selective eating behaviours	Case series (1) 3-year-old autistic male (2) 9-year-old autistic female	(1) Consumption of 13 foods, primarily white or beige in colour (no fruits or vegetables). Refused to consume milk from anything other than a baby bottle (2) Severe food and drink selectivity and challenging behaviour. All meals consumed while lying in her parent's bed. Refusal to drink from age-appropriate cup. Lack of	• Physical guidance using a Nuk brush used to increase acceptance of solids and liquids (1) Improvement in acceptance of foods and liquids. Over time, session durations decreased and feeding sessions more efficient (2) Independent acceptance (picking up the spoon/cup without assistance and placing food/liquid in mouth) occurred very quickly (Analysis 2). With Nuk procedure, independent

				(3) nutritional content and consumption of calories well above what was recommended for her age	(3) acceptance increased for all food and liquids except macaroni and cheese
30	Marshall et al. (2013)	To provide information about the current management of feeding difficulties in children with autism	n = 96 respondents (clinicians in Australia working with autistic children with feeding difficulties)	• Patients presented with a number of feeding difficulties including restricted diet, inability to tolerate changes in appearance, type or texture and limited food repertoire (eating the same foods at every meal) • 41% of patients presented with low weight (just 8% were overweight) • Dependency on enteral feeding (35%) • Oral nutritional supplementation	• Electronic survey administered to clinicians • Speech-language pathologists most commonly provide feeding services to this population • Although some trends towards specific service delivery and interventions were observed, overall results indicated variability in practice • Low levels of clinician confidence and perceived success of therapy observed
31	Keown et al. (2014)	To describe the case of a young child with a restricted diet and nutritional deficiencies	Case study 4-year-old autistic male	• Restricted dietary intake, limited to chocolate bars, wafers, battered chicken breast and dry bread • Food selectivity specific to type and brand • Consumption of excessive amounts of carrots juice (in excess of 2.5L per day) • Orange discolouration of the skin, raised serum carotene in the blood and vitamin D deficiency	• Consumption of carrot juice weaned gradually • Easting behaviours addressed with structured mealtimes and strategies implemented for diet diversification • Vitamin D and calcium supplement • Specialist, multimodal input from autism service, speech and language therapists, dietetics, occupational therapy and educational psychology • Although carrot juice consumption was significantly reduced, patient refused to take vitamin D supplement and 6-month follow-up blood tests show persistent deficiency
32	Levin et al. (2014)	To discuss non-removal procedures used to address two cases of severe food selectivity	Case series (1) 4-year-old autistic male (2) 4-year-old autistic female	(1) Failure to thrive, receiving more than 90% of calories via gastrostomy tube. Consumption of 4-5 ounces of water or juice, small amounts of chicken stars soup and corn puffs, popcorn and crackers (held in the mouth until dissolved). Also, milk-soy protein intolerance, food allergies, gastroesophageal reflux and vomiting (2) Limited diet (vanilla rice milk, pear juice, Stages 2 and 3 baby foods) Diagnosis of dysphagia and followed gluten-free, casein-free diet	(1) Outpatient treatment feeding disorders programme. Non-removal procedures increased acceptance of 12 pureed foods, but participant began frequently packing starches and peas. This was successfully reduced with a combination of re-distribution, swallow facilitation and chaser treatment. On discharge, the patient consumed age-appropriate portions of several table foods with just 2 ounces of Neocate Jr. via gastrostomy tube (2) Day-treatment feeding disorders programme. Multi-component treatment needed to reduce packing - re-distribution, swallow facilitation and chaser, as well as differential positive and negative reinforcement.
33	Williams and Hendy (2014)	To compare child and parent variables associated with complete oral calorie	Chart review 281 children referred to hospital-based feeding clinic	• Underweight (below 5th percentile for height) • Restricted diet • Reliance on nutritional supplements	• Chi-square analyses compared children who received supplements with those who didn't

		supplement use among children with feeding problems	n = 114 who received supplements (70.2% male, mean age 60.1 months, 23.7% with autism) n = 167 not receiving supplements (79.6% male, mean age 67.5 months, 35.9% with autism)	• Mealtime behaviour problems such as lack of enjoyment, slow eating, food fussiness	• Children receiving supplements for feeding difficulties were younger, more underweight, showed more food satiety, were slower eaters and showed less food responsiveness and less food enjoyment • 78.2% of children receiving supplements were normal weight or overweight, suggesting that parents use them to tackle severe food selectivity (and not just low weight/weight loss)
34	Baird and Ravindranath (2015)	To review the clinical course of a child with a severely limited diet and vitamin deficiencies	Case study 11-year-old autistic male	• For several years, refusal to eat anything except chicken nuggets from a particular fast-food restaurant and occasional French fries • Had not eaten fruit, vegetables or any milk products for a number of years • Deficient in multiple micronutrients, including thiamine, pyridoxine, vitamin A, copper, iron and vitamin K • Several serious health issues recorded, including liver dysfunction and lactic acidosis	• Patient hospitalised and parenteral nutrition initiated • Gradually increased nasogastric tube formula feeds (Pediasure) • Test of liver dysfunction gradually improved and patient discharged 1-month after admission to chronic care facility • Patient lost to follow-up
35	Johnson et al. (2015)	To pilot a behavioural parent training programme for autistic children and feeding problems	Pilot trial n = 14 autistic children (aged 2-7 years)	• Feeding problems defined by specific criteria including: a definite concern about the child's nutrition, child engages in disruptive mealtime behaviours, is selective about texture, colour, brand, appearance • One participant underweight (BMI < 5%)	• Parents participated in a 9-session programme delivered individually over 16 weeks • Feeding concerns and disruptive mealtime behaviours significantly reduced over the trial • Significant reduction in parental stress
36	Tanner and Andreone (2015)	To describe the use of a graduated exposure intervention to treat a child with severe food selectivity	Case study 3-year-old autistic male	• Consumption of four foods only, 3-5 cups of apple juice per day and reliance on nutritional supplement drink • Food selectivity by brand, texture, temperature and utensil used	• 12-step graduated exposure food hierarchy used as well as parent-training • 9-months post-treatment, participant's food repertoire had increased to more than 50 items • Food refusal behaviour had decreased
37	Amos et al. (2016)	To describe the case of a young adult with a diet severely deficient in ascorbic acid, resulting in scurvy	Case study 17-year-old autistic male	• Diet very limited, consisting primarily of grilled cheese sandwiches, cottage cheese, chocolate milk and soda (no fruits or vegetables) • Food selectivity due to textural aversion • Patient presented to medical care with fever, jaundice, anaemia, constipation and left knee arthritis • Vitamin C level very low	• Diagnosis of scurvy • Started on intravenous ascorbic acid 250mg daily, which transitioned to 250mg orally twice daily • Decreased swelling in left knee and patient was discharged home • 8-months post-discharge, patient reported no joint pain or selling, jaundice had resolved and vitamin levels were normal

					• He remained on vitamin C and multivitamin supplementation
38	Castro et al. (2016)	To evaluate dietary intake and identify feeding problems in participants with autism compared to neurotypical matched controls	Case control study 49 males with autism (aged 4-16 years) and matched controls	• Limited food repertoire, nutritional deficiency, low height-for-age, low BMI-for-age	• 3-day food record taken and nutrient intake compared to the Dietary Reference Intake according to age • Behaviour Pediatrics Feeding Assessment Scale (BPFA) used to evaluate parent/caregiver feelings • Autistic patients consumed on average more calories than controls, had a limited food repertoire, and consumed inadequate levels of various nutrients (including calcium, sodium, iron and vitamin C) • BPFA scores higher in the autistic group, indicating higher levels of problematic feeding behaviour
39	González and Stern (2016)	To explore the co-occurring behavioural difficulties that present alongside severe food refusal/selectivity	Descriptive study 54 children, aged 2-12 years (28% female) n = 15 with autism	• Tube dependence (gastrostomy or nasogastric) (59% of sample) • Liquid dependence (receiving at least 75% of caloric intake from liquids orally) (6%) • Selectivity based on type or texture/limited food repertoire (consumption of type or amount not sufficient to be developmentally and/or nutritionally appropriate) (35% of sample)	• Medical charts of patients reviewed – age, presence of developmental delay/autism, and type of feeding problem examined as predictors of behavioural support • Approximately half of the sample received coaching or individualised intervention • Younger age was a predictor of individualised caregiver coaching • Individualised behavioural interventions were more likely to be provided to autistic children or those with developmental delays • Despite that, behavioural concerns outside of the feeding difficulty (aggression, disruption, self-injury) appear to be common for children with and without developmental delays and autism
40	Ma et al. (2016)	To review the number of cases of scurvy seen at Boston Children's Hospital over a period of 18 years	Retrospective chart review/case studies n = 7 males (3-11 years) 57% with autism	• All children had extremely picky eating habits, choosing from a selective list of foods with minimal sources of vitamin C • 3 cases presented. Symptoms included limping, gingival swelling, knee and hip pain, fatigue, weight loss	• Treatment with vitamin C and a multivitamin led to immediate improvement in symptoms
41	Cosbey and Muldoon (2017)	To evaluate the effectiveness of a family-centred feeding intervention Easing Anxiety Together	(1) 6-year-old autistic male (2) 8-year-old autistic male (3) 7-year-old autistic male	(1) Refusal to remain at the table to eat family meals. Preference to consume granola bars and other snack foods at non-mealtime	• Intervention-coaching phase taught caregivers how to implement strategies to increase food acceptance

		with Understanding and Perseverance (EAT-UP) to promote food acceptance		(2) Typically ate meals alone at a desk in the living room or in the car. Tendency to spit masticated food into his palm and put it back in his mouth multiple time before swallowing. Participants was significantly overweight, primarily consuming highly processed fast food and very particular about brand (no fruits and vegetables) (3) Diet consisted mainly of crunchy and sweet food and milk (reliance on nutritional supplement drink). No fruit or vegetables and dislike of wet foods. No social component to meals and participant often ate alone in front of the television	• Once the caregiver demonstrated the ability to implement at least 90% of the strategies, they moved onto an intervention-independent phase • Data collected via direct observation and pre- and post-intervention questionnaires • All children demonstrated increases in food acceptance and dietary diversity, as well as a decrease in challenging mealtime behaviours
42	Lucarelli et al. (2017)	To describe the management of a young autistic child with ARFID	Case study 4-year-old autistic female with ARFID	• Persistent bottle refusal and acceptance of few pureed foods • Diet consisted of French fries, Ritz crackers, pretzels and 32 ounces of soy formula daily • Other aspects of feeding controlled including insistence on parking a specific space at a fast-food restaurant and drinking from a particular cup	• Therapy using a systematic desensitisation approach with rewards • Mother also advised to support child at home • Some early progress observed but parents decided to discontinue treatment with concerns that it was too harsh • Weight is stable but diet still very limited
43	Planerova et al. (2017)	To describe the presentation and treatment of a child with significant nutritional deficiencies as a result of behavioural food aversions	Case study 10-year-old male with Asperger's syndrome BMI 15.29 kg/m^2	• Limited food repertoire. Diet for the last several years of McDonald's pancakes, potato bread and plain cheese pizza • 6 months before presenting for medical care, patient was only consuming water and bread • Complaints of left ankle pain, refusal to walk and gingival bleeding • Other symptoms included cachexia, swollen gums, poor oral hygiene and significant anxiety	• Admittance to hospital for 17 days • Patient did not tolerate a nasogastric tube so a percutaneous gastrostomy tube was placed for enteral feeds (Pediasure) • Repletion of vitamin deficiencies and medication to treat anxiety, gingivitis and leg pain
44	Taylor et al. (2017)	To compare the effectiveness of using applied behaviour analytic interventions to address feeding difficulties and tube dependence in children enrolled in a hospital-based feeding programme	Children with a diagnosis of autism (n = 25) or cerebral palsy (n = 33) Age range 20-148 months (mean = 69.53)	• Food refusal resulting in chronic gastrostomy tube dependence • Long history of previous failed attempts to eliminate tube dependence	• Individualised behavioural treatment consisting of escape extinction • Treatment success similar across groups - increase in gram consumption and decrease in food refusal

45	Kinlin et al. (2018	To describe the clinical presentation of a patient with significant nutritional deficiencies resulting in scurvy	Case study 10-year-old autistic male Weight below 3rd percentile	• Long-standing significantly restricted diet • Mild anaemia and deficient in vitamins C, A, D and zinc (diagnosis of scurvy strongly suspected) • Presented to emergency department with right ankle swelling and bruising	• With treatment, the patient experienced rapid improvement in symptoms • Physiotherapy arranged for ongoing rehabilitation • Referral made to nutrition clinic and vitamin supplementation continued post-discharge
46	Muldoon and Cosbey (2018)	To outline the usefulness of the family-centred feeding intervention Easing Anxiety Together with Understanding and Perseverance (EAT-UP)	Three families of children with autism receiving services from an outpatient department (1) 3-year-old autistic male (2) 5-year-old autistic male (3) 4-year-old autistic male	(1) Repetitive diet, eating the same food every day. Comorbid diagnoses of insomnia, expressive language disorder and constipation. Not able to remain at the table during mealtime (2) Limited diet of crackers, cookies, chips and yoghurt. Additional diagnoses of mixed receptive-expressive language disorder and global developmental delay (3) Feeding difficulties and slow weight gain. Difficulty following directions and additional diagnoses of expressive language disorder and global developmental delay	(1) Increased food acceptance and dietary diversity, decrease in problem mealtime behaviours (2) Increase in variety of foods consumed, acceptance of different brand and flavour of yoghurt (3) Weight gain of 8 lbs and increase in food repertoire
47	Seiverling et al. (2018)	To compare a behavioural feeding intervention with and without pre-meal sensory integration therapy to treat severe food selectivity	(1) 5-year-old autistic male (2) 6-year-old autistic female	(1) Completely dependent on paediatric formula and whole milk via baby bottle to meet his nutritional needs. Feeding therapy at school had resulted in small licks of soup, apples and strawberries. Refusal to try anything else (2) Diet included yoghurt, hot breakfast cereal and one type of cookie. Weight had dropped from 73rd to 56th percentile in the last year and a half	• Behavioural feeding intervention + sensory integration therapy - child bite and drink consumption and total intake increased, with decreases in inappropriate mealtime behaviours • Behavioural feeding intervention alone - Sensory integration therapy was discontinued but treatment progress remained stable • Caregiver training was given to continue intervention at home • Follow-up data showed maintenance of treatment gains over time
48	Sharp et al. (2018)	To examine the demographic characteristics, anthropometric parameters, risk of nutritional inadequacy, dietary variety and problematic mealtime behaviours of a sample of children presenting to a feeding clinic in the US	Medical record review 70 children (age 2-17 years) with autism and probable ARFID	• 67% of the sample omitted vegetables (n = 47) and 27% omitted fruits (n = 19) • 78% consumed a diet at risk of five or more inadequacies (vitamin D, fibre, vitamin E, calcium) • Severe food selectivity was not found to be associated with compromised growth or obesity	• The study underscores the importance of evaluating nutritional status in children with autism

			between Jan 2014 - Jan 2016		
49	Johnson et al. (2019)	To evaluate the efficacy of a new 11-session parent training programme to address feeding problems	Pilot RCT 42 children with autism (age 2-11 years)	• Substantial feeding/mealtime problems (score greater than 54 on the Brief Autism Mealtime Behaviour Inventory-Revised (BAMBI-R) • Food selectivity, food refusal, disruptive mealtime behaviours • Nutritional deficiencies	• Participants randomly assigned to 11 sessions of the intervention over 20 weeks or a waitlist control • The intervention group showed significantly greater improvement than the control group on measures of feeding problems including food selectivity and disruptive mealtime behaviours
50	Peterson et al. (2019)	To evaluate the effects of an intervention used to encourage independent acceptance and mouth clean of healthy, novel and non-preferred foods	RCT n = 6 children with autism (n = 4 5-years old, n = 1 3-years-old)	• Food selectivity (more than 3 but less than 20 foods consumed by mouth) • Diet nutritionally deficient (i.e., nutrition from one source, daily consumption of less than 80% vitamins and minerals)	• Patients randomly assigned to an applied behaviour analytic intervention or a wait-list control (wait-list control patients later exposed to intervention) • Independent acceptance and mouth clean of 16 novel foods was recorded • % of independent acceptance and mouth clean increased for the intervention group but not for the control group (until intervention was implemented)
51	Rafee et al. (2019)	To present the case of an adolescent with food selectivity resulting in severe vitamin C deficiency	Case study 14-year-old autistic male	• Limited food repertoire (narrow range of foods consumed, but consumed large amounts of preferred foods) • Food selectivity based on texture, taste and preparation method. Fruit and vegetables denied (apart from bananas) and severe aversion to citrus fruits • Medical symptoms included pain and swelling of left leg, anaemia, anxious, dehydrated, bruising, painful joints, recurrent nosebleeds and gingival bleeding (suspected scurvy)	• Admission to hospital for 7 days • Patient was rehydrated and given antibiotics and a blood transfusion after drop in haemoglobin • Vitamin C and iron replacement therapy • Education on nutrition and diet provided • 22 weeks post-discharge – complete resolution of leg swelling, corrected vitamin C and iron levels, improved haemoglobin levels • Three-year follow-up – patient seen by occupational therapy, psychology, gastroenterology to address food selectivity. Marginal improvements noted and use of vitamin supplementation in diet (still experiencing ulcers and chronic constipation)

52	Seiverling et al. (2019)	To develop and test the 22-item Sensory Eating Problems Scale (SEPS)	449 caregivers and their children (67.9% male, mean age = 69.59 months) Children divided into three groups: autistic (n = 156), other special needs (n = 144), no special needs (n = 149)	• Children referred to feeding clinics for various problems including failure to gain weight, dependence on enteral feeding or oral supplements, difficulties with texture and limited diet variety	• The 22-item SEPS allows clinicians and researchers to examine specific sensory eating problems, including Food Touch Aversion, Single Food Focus, Gagging, Temperature Sensitivity, Expulsion and Overstuffing • Three SEPS subscales (Food Touch Aversion, Expulsion and Overstuffing) were greater in autistic children and those with other special needs • Food Touch Aversion, Gagging, Temperature Sensitivity and Expulsion were associated with younger age
53	Smith et al. (2019)	To compare the use of escape extinction procedures combined with noncontingent access to escape extinction alone to increase liquid consumption	Case study 4-year-old autistic male	• Inappropriate mealtime behaviours and refusal to eat (gagging, coughing, hitting) • Dependence on gastrostomy tube for caloric and nutritional intake • Failure to thrive	• The results indicated that a combination of escape extinction procedures along with noncontingent access to a reinforcer (music) was more effective at increasing oral consumption and decreasing inappropriate mealtime behaviours • At follow-up, the patient was consistently accepting an average of 60 drinks per 50-min session • Parent training was given so that treatment could continue to be implemented at home
54	Zavaleta & Burt (2020)	To present the case of an autistic adolescent and a limited diet resulting in severe vitamin C deficiency	Case study 13-year-old autistic male	• Significantly restricted diet largely consisting of cheese crackers and soda • Recent history of abdominal pain, progressively decreasing haemoglobin, possible gingivitis, fatigue, mild anaemia • Significant vitamin C deficiency	• Hospital admittance • 7-day course of 100mg vitamin C intravenous every 8 hours normalised the child's vitamin C level
55	Taylor (2020)	To assess the effectiveness of the side deposit procedure (placing food into the side of the mouth) in an intensive home-based programme setting in Australia	2 male autistic children	• Child 1 (age 5) - no fruits or vegetables, very limited diet, did not dine out or consume school meals. No self-feeding • Child 2 (age 4) - baby bottle/formula dependence, iron deficiency requiring supplementation, no foods eaten from any food groups. Would only consume crackers and cookies, and a homemade fruit smoothie. Would not accept multivitamins and some liquid medications	• Child 1 (1 month follow-up) – mother reported that child was eating everything at home and in the community. At 3-month follow-up, consumption was 100% and independence high. 3-year follow-up - willing to try new foods but some rigidity (i.e., preferring vegetables boiled his mother's way) • Child 2 (2 week follow up) - consumption at 100%. 6-month follow-up, child reported to eat an adequate volume at home and mealtime behaviour better but would not eat a wide variety at school or missed foods (casseroles, Spaghetti Bolognese)

*NOTE. NG = nasogastric; GI = gastrointestinal; CBT = cognitive behavioural therapy; PDD = pervasive developmental disorder; PDD-NOS = pervasive developmental disorder not otherwise specified; RCT = randomised controlled trial

FIGURE 1. Flow diagram of reviewed studies according to Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines.