

Physical health complications in children and young people with avoidant restrictive food intake disorder (ARFID): a systematic review and meta-analysis

Rachel Marie James ¹, Jonathan O'Shea ¹, Nadia Micali ^{1,2},
Simon J Russell ¹, Lee D Hudson ¹

To cite: James RM, O'Shea J, Micali N, *et al*. Physical health complications in children and young people with avoidant restrictive food intake disorder (ARFID): a systematic review and meta-analysis. *BMJ Paediatrics Open* 2024;**8**:e002595. doi:10.1136/bmjpo-2024-002595

► Additional supplemental material is published online only. To view, please visit the journal online (<https://doi.org/10.1136/bmjpo-2024-002595>).

Received 28 February 2024
Accepted 18 June 2024



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹UCL GOS Institute of Child Health, London, UK

²Capital Region of Denmark Mental Health Services, Copenhagen, Hovedstaden, Denmark

Correspondence to

Rachel Marie James; rachel.james.22@ucl.ac.uk

ABSTRACT

Background Avoidant restrictive food intake disorder (ARFID) is a feeding and eating disorder with known acute and longstanding physical health complications in children and young people (CYP) and commonly presents to paediatricians.

Objective To systematically review the published literature on physical health complications in CYP with ARFID using Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Methods A systematic search of PubMed, Embase, Web of Science, PsycINFO and Cochrane Library was performed on 14 February 2024. Studies reporting physical health complications in CYP ≤25 years with ARFID were included. We pooled studies for meta-analysis comparing ARFID with healthy controls or anorexia nervosa (AN).

Results Of 9058 studies found in searches, we included 132 studies. We found evidence for low weight, nutritional deficiencies and low bone mineral density. CYP with ARFID can present across the weight spectrum; however, the majority of CYP with ARFID were within the healthy weight to underweight range. Most studies reported normal range heart rates and blood pressures in ARFID, but some CYP with ARFID do experience bradycardia and hypotension. CYP with ARFID had higher heart rates than AN (weighted mean difference: 12.93 bpm; 95% CI: 8.65 to 17.21; n=685); heterogeneity was high (I^2 : 81.33%).

Conclusion There is a broad range of physical health complications associated with ARFID requiring clinical consideration. Many CYP with ARFID are not underweight yet still have complications. Less cardiovascular complications found in ARFID compared with AN may be related to chronicity.

PROSPERO registration number CRD42022376866.

INTRODUCTION

Avoidant restrictive food intake disorder (ARFID) is a feeding and eating disorder (ED) characterised by persistent restricted intake in quantity or variety of food.¹ Such restrictive feeding results in one or more of: a failure to meet nutritional or energy needs;

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Avoidant restrictive food intake disorder (ARFID) is a feeding and eating disorder which often results in malnutrition and its consequent physical health complications in children and young people (CYP).

WHAT THIS STUDY ADDS

⇒ CYP with ARFID can present across the whole weight spectrum; ARFID is not exclusively a low-weight eating disorder.
⇒ CYP with ARFID are at risk of several other complications such as low bone mineral density and nutritional deficiencies which do not discriminate based on the individuals weight.
⇒ CYP with ARFID on average present with higher heart rates and lower levels of hypotension and bradycardia than individuals with anorexia nervosa (AN), despite similar levels of underweight.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our review has highlighted the need for comprehensive physical health checks for every individual with ARFID, regardless of their weight status.
⇒ Our review has also highlighted the need for a more nuanced approach when assessing for risk in CYP with ARFID compared with what is currently in use for AN.
⇒ There are some critical gaps in the literature that warrant further study such as longitudinal analysis and more representative samples.

dependence on oral or enteral supplements and/or significant impacts on psychosocial functioning.¹ Three non-mutually exclusive presentations tend to motivate food-related behaviour in ARFID: (1) lack of interest in food or lack of appetite; (2) sensory sensitivity to food (eg, based on foods texture, appearance and smell) and (3) fear of the consequences of food (eg, choking, vomiting).¹

Consequently, ARFID is distinct from anorexia nervosa (AN) as the driving motivations behind the eating behaviour noticeably lack a focus on body weight or image.¹ The onset of ARFID is usually in childhood (<12 years of age),² with a prevalence between 3.2% and 15.5% in primary school-aged children and ~0.5% across all ages.²

While ARFID is considered primarily a psychological disorder, persistent feeding behaviour regularly results in failure to meet energy/nutritional needs¹ leading to physical complications carrying a range of potential risks. These can be acute when weight loss leads to cardiovascular and temperature instability,³ or more longstanding, leading to growth faltering and low bone mineral density (BMD).⁴ Such physical impacts mean that children and young people (CYP) with ARFID commonly present to paediatricians, and knowledge of physical health assessment and management is essential for those working medically with CYP.

As ARFID is a relatively new diagnosis (first defined in 2013¹), research has emerged later than for other EDs, and so more established physical health findings from AN (given restricted intake) have been applied as a model, in particular to acute risk assessment.⁵ This is potentially problematic due to important differences between ARFID and AN, meaning that such application may not be valid. ARFID tends to have an earlier age of onset, malnutrition is generally more longstanding and there are specific food avoidances leading to nutritional deficiencies.² A larger body of published evidence on the physical impact of ARFID in CYP has emerged, providing opportunity for a synthesis of the literature to aid better prediction, prevention, tailor clinical treatments and identify important areas for further research. A systematic review on this topic has not been published before. We conducted a systematic review of the published literature and meta-analyses using Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines⁶ to examine for both acute and chronic physical health risks in CYP with ARFID.

METHODS

Search strategy

We searched for published full-text articles on ARFID with any physical health complication in PubMed, Embase, Web-of-Science, PsycINFO and The Cochrane Library from database inception to 14 February 2024. Relevant search terms for ARFID and physical health were used for each electronic database (online supplemental file 1). We also conducted citation searches of included studies. We registered a broader systematic review for physical health complications in ARFID in all ages with PROSPERO, and here we present only the findings for CYP (≤25 years of age).

Inclusion criteria were: (1) peer-reviewed full-text publications reporting any kind of primary data on physical health parameters in individuals with ARFID except for non-systematic reviews; (2) studies containing one

or more participants ≤25 who had been diagnosed with ARFID before or at the time of publication; (3) studies in any language; (4) studies from any geographical area.

Exclusion criteria were: (1) studies mixing adults with CYP throughout reporting; (2) studies not including any data on physical complications in ARFID; (3) studies only reporting physical complications caused by comorbidities of ARFID or other pre-existing conditions.

Two researchers (RMJ and JO) independently screened titles and abstracts for inclusion using the online systematic review tool, Covidence. Once an agreement was met, full-text articles were screened independently for inclusion. LDH provided adjudication on disagreement.

Data extraction and quality assessment

We extracted data using a customised form: (1) general study information; (2) general characteristics of participants; (3) anthropometric measurements (weight, standardised weight for age (weight z-score), body mass index (BMI), standardised BMI for age (BMI z-score) or percentage median BMI (%MBMI, % of subject BMI of median BMI for age and sex); (4) details of physical health complication; (5) any comparisons between ARFID and healthy controls (HCs) or AN.

We assessed bias using the Newcastle-Ottawa Scale (NOS) for observational studies, Risk of Bias In Non-randomised Studies for non-randomised studies and Risk of Bias-2 for randomised, controlled studies. We used the CAsE REports guidelines for case studies and series for reporting completeness and evidence quality.

Meta-analysis

We pooled studies reporting continuous variables (anthropometric measures and heart rate (HR)) in ARFID compared with HC or AN in meta-analysis when there were three or more studies, using STATA (V.17, StataCorp). Where the same data were reported in more than one paper, we used the most complete sample. For longitudinal studies, we included baseline data.

We generated standardised mean difference (SMD; Hedge's-g) for studies reporting same outcomes but different measures (eg, BMI z-score and %MBMI) and weighted mean difference (WMD) where measures were the same across all studies. We used random effects models due to high heterogeneity between the studies (Q ($p < 0.1$) and I^2 ($> 75\%$)) and performed meta-regression to examine for potential common study variables moderating effect sizes. We ran sensitivity analyses by removing studies with the highest degree of bias and study outliers based on methodology or study population to examine for impact on effect sizes. We assessed for publication bias with funnel plots and Egger's test for meta-analyses including more than 10 studies.⁷

RESULTS

A summary of search findings is shown in figure 1. Of 9058 studies found in initial searches, we included 132

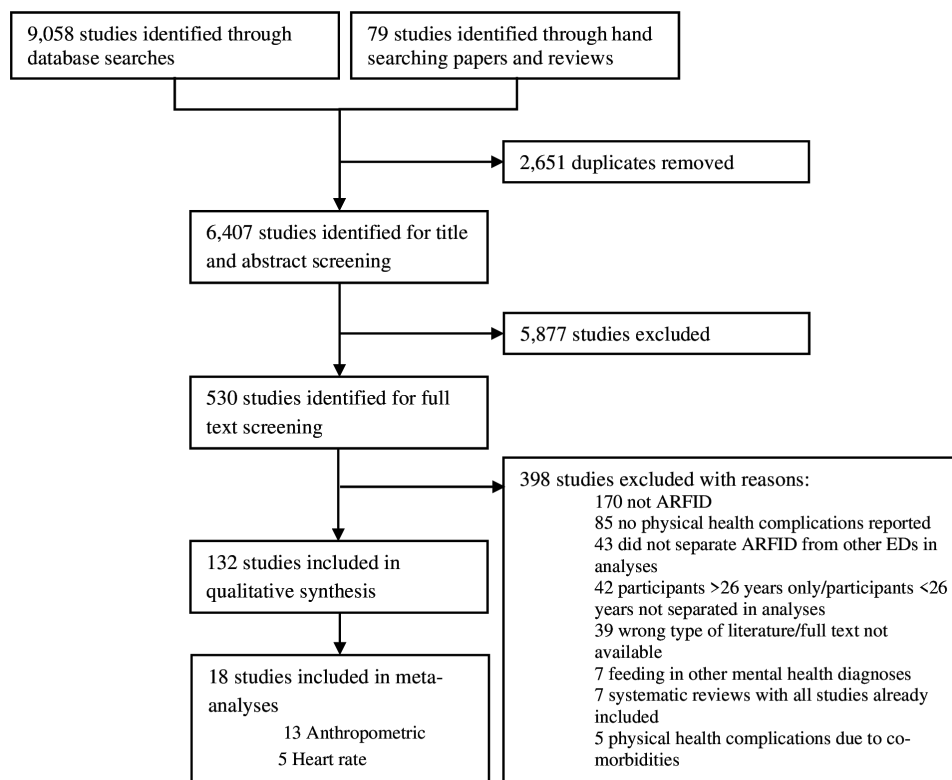


Figure 1 Flow diagram of searches and study selection. ARFID, avoidant restrictive food intake disorder; ED, eating disorder.

studies. All the included studies are described in online supplemental table 1 and referenced in the reference list; however, not all are cited in the text of this paper. Disagreement during the abstract screen was 2.45%. There was no disagreement on the full-text screen. We found studies reporting on the following: anthropometrics (n=128), cardiovascular complications (n=27), BMD (n=12), nutritional deficiencies (n=34), puberty and menstruation (n=13) and other complications that did not fit into the previous categories (n=14). We found 63 cross-sectional studies, 8 longitudinal, 9 research trials (baseline data reported only) and 55 case studies/series. Studies originated from the USA, Canada, Brazil, Japan, Indonesia, Australia, Turkey and Europe. The majority (n=105) of studies were exclusively on children and adolescents ≤ 18 years, only 15 of which were exclusively on children ≤ 5 years. The remaining 27 studies were mixed samples of CYP (≤ 25 years).

Quality of studies

Quality assessments are shown in online supplemental table 1. Median case completeness of case studies was 75% (range: 36%–93%). Median NOS score in observational studies were: case-controls: 6 out of 9* (range: 4–9*); cohorts: 6 out of 9* (range: 4–8*); cross-sectional: 6 out of 10* (range: 4–9*). We also found five out of the nine research trials had moderate risk of bias; the remaining four had high risk of bias.

Anthropometrics

We found 128 studies reporting anthropometric data (online supplemental table 1), including 15 studies

which compared HC^{8–23} and 28 which compared AN with ARFID.^{8–10 14 16 19 23–45}

Seven of the 13 studies reporting weight distribution of CYP with ARFID found the majority were living with underweight (defined within the papers as < 5 th BMI centile or ≤ -2 weight z-score),^{15 18 46–50} while six found the majority were within a healthy weight range (defined within the papers as 5th to 85th BMI centile or -2 to 1 weight z-score).^{51–56}

We found six studies to pool in meta-analysis comparing BMI z-score or %MBMI in ARFID to HC (figure 2), producing a large overall effect size for lower standardised BMI scores in ARFID (SMD: -0.99 ; 95% CI: -1.40 to -0.58 ; n=846)^{13–15 18 21 23} compared with HC. Heterogeneity was high (I^2 : 79.81%). All pooled studies were in children ≤ 18 years old, except one study on CYP aged 10–23 years¹³ (removal had no significant impact on effect size or heterogeneity). All studies were clinical samples, except one which was a community sample and was the only study of ‘poor’ quality rather than ‘good’ quality as assessed by the NOS²¹ (removal increased the effect size (SMD: -1.14 ; 95% CI: -1.46 to -0.82 ; n=558) and reduced the heterogeneity, I^2 : 56.95%).

We also found 15 studies to pool for meta-analysis comparing BMI z-score or %MBMI in ARFID versus AN, producing no overall difference in effect size (SMD: -0.00 ; 95% CI: -0.31 , 0.31 ; n=1689; figure 3)^{9 14 16 19 23 25 27 31 33 34 36 38–40 44}; heterogeneity was high (I^2 : 86.57%). Of the 15 studies included, 11 were of children ≤ 18 years old,^{14 16 19 23 25 31 33 34 38 40 44} and the remaining four studies included CYP < 25 years of

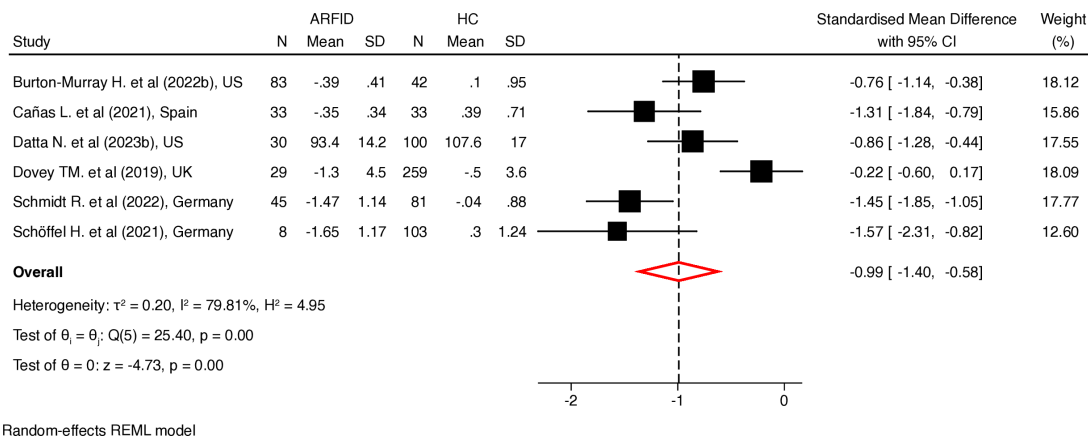


Figure 2 Forest plot showing standardised mean difference in BMI z-scores and %Median BMI between ARFID (n=228) and HC (n=618). 95% CIs and study weights and indicated. The overall effect size was calculated using a random effects model. ARFID, avoidant restrictive food intake disorder; BMI, body mass index; HC, healthy control.

age^{9 16 27 36 39} (the removal of which did not affect effect size or heterogeneity). All studies were in clinical samples, except two^{16 23} (removal of which did not affect effect size or heterogeneity). Most studies were of 'good' quality; however, six were of 'fair' quality.^{19 31 33 38 40 44} Removal of 'fair' quality studies^{19 31 33 38 40 44} increased the difference between ARFID and AN; however, SMD was still insignificant (SMD: 0.18; 95% CI: -0.19 to 0.54; n=1004) and heterogeneity was still high (I^2 : 82.85%). A funnel plot was not perceived to display asymmetry, confirmed with Egger's test ($p=0.64$). Meta-regression using available data on age and sex across studies found no significant associations with effect size (data not shown).

Most of the longitudinal anthropometric data we found came from case studies (n=14),⁵⁷⁻⁷⁰ most reporting rapid weight loss in the months before presentation. We found three larger studies reporting longitudinal data.^{39 46 71}

One study found that individuals with ARFID had lower pre-diagnosis BMIs and lost significantly less weight during their illness than patients with AN (%MBMI lost: 15% vs 21%; $p=0.03$).³⁹ In addition, another study reported individuals with ARFID lost a mean of 9.6 ± 9.1 kg before presentation for treatment.⁷¹ The only study that followed individuals with ARFID for multiple years found that the percentage of them that had severe acute malnutrition (weight z-score ≤ -2 ; from 76% at 2 years of age to 52% at 11 years of age) and those who had severe chronic malnutrition (height z-score ≤ -2 , 51% to 25%) declined over the years.⁴⁶ Five cross-sectional studies mentioned growth faltering or stunting in ARFID; the reported prevalence of growth delay across all five studies ranged from 1.4% to 51%.^{46 51 52 54 55}

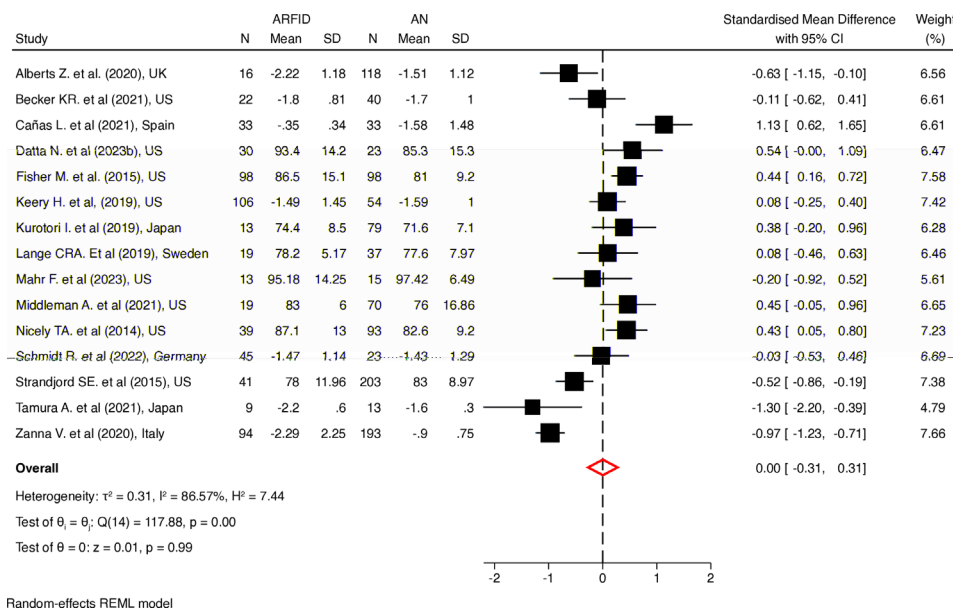


Figure 3 Forest plot showing standardised mean difference in BMI z-scores and %Median BMI between ARFID (n=597) and AN (n=1092). 95% CIs and study weights and indicated. The overall effect size was calculated using a random effects model. AN, anorexia nervosa; ARFID, avoidant restrictive food intake disorder; BMI, body mass index.

Cardiovascular complications

We found 27 studies containing data on cardiovascular parameters in ARFID (online supplemental table 1).^{8 19 24 32 33 35 39 41 58 60 61 63 67 70–82} One compared ARFID to HC⁸ and seven compared ARFID to AN.^{8 19 24 33 35 39 41}

All non-case studies that contained data on HR or blood pressure (BP) in individuals with ARFID found the mean HR and BP to be within a normal range for age.^{8 19 24 33 35 41 75 78 82} Several studies did, however, report some individuals with ARFID (3.92%–52.6%) had bradycardia, and around 2% had hypotension.^{32 33 39 70 73–75} Five case studies reported tachycardia in ARFID^{58 67 72 80 83}; most were reported in the context of electrolyte abnormalities or severe nutritional deficiencies. Two studies investigated potential risk factors for variance in HR and BP within the ARFID population.^{75 77} One study identified a subgroup within ARFID that had rapid weight loss and a shorter length of illness also had a lower HR.⁷⁷ In contrast, another study found individuals with ARFID who had acute compared with chronic ED symptom onset had similar HRs and BPs (acute: 76.2±15.5 beats per minute (bpm), chronic: 79.4±15.1 bpm, NS).⁷⁵ The weight status of the ARFID participants also had no significant impact on their HR or BP, but CYP <12 years had significantly higher HRs (82.40±17.84 bpm vs 76.15±12.23 bpm; $p<0.05$) and lower systolic blood pressure (109.72±10.14 vs 115.61±8.31; $p<0.01$) than CYP ≥12 years.

All studies comparing ARFID to AN, reported an average higher HRs, lower prevalence of bradycardia and higher BP in ARFID, despite similar BMIs.^{8 19 24 33 35 39} We found five studies to pool in a meta-analysis comparing HR in ARFID to AN, showing that mean HR was greater in ARFID (WMD: 12.93 bpm; 95% CI: 8.65 to 17.21; $n=685$; figure 4).^{8 19 24 33 35} Heterogeneity was high (I^2 : 81.33%). All studies included were clinical samples, with two studies of 'good' quality^{8 24} and three of 'fair' quality.^{19 33 35} Only one study included had CYP over 18 years old (10–22 years old)⁸; removal of which increased the difference in HR between ARFID and AN (WMD: 15.5 bpm; 95% CI: 12.87 to 18.19; $n=623$). All studies used retrospective medical data apart from two, which were cross-sectional studies^{8 35} which when removed increased the mean difference in HR between ARFID and AN to

16.20 bpm (95% CI: 13.28 to 19.13; $n=517$) and reduced the heterogeneity to null (I^2 : 0.00). There was no difference in mean standardised BMI between ARFID and AN in all studies included, except for one¹⁹ where individuals with AN had a lower standardised BMI; removal of which slightly reduced the mean difference and heterogeneity (WMD: 11.69; 95% CI: 7.08 to 16.31; $n=398$; I^2 : 75.91%). Meta-regression and subgroup analysis found no moderators to this relationship (eg, age, percentage female, type of study, year published).

Bone mineral density

We found 12 studies that reported data on BMD within ARFID (online supplemental table 1)^{22 24 25 59 84–88}; eight of which were case studies,^{59 70 80 81 84–87} one compared BMD in ARFID to HC²² and two compared BMD in ARFID to AN.^{24 25}

In the case studies/series that stated BMD z-score, all individuals with ARFID, except for two,^{85 86} had BMD z-scores ≤−2 (BMD z-score range: spine 0.4 to −4.1; hip −3.1 to −4.6).^{59 81 85 87} Furthermore, one cross-sectional study reported that 25% of individuals with ARFID had BMD z-scores ≤−2 in their spine while 77% had BMD z-scores ≤−1.²⁴ Another study found that the mean BMD z-score in individuals with ARFID was −2.46.⁸⁸ Only one study mentioned Bone Mineral Density Apparent Density (BMAD) z-scores, where the mean BMAD z-score in individuals with ARFID was −1.44.²⁵ Lower BMI, lower BMI z-score, amenorrhea and delayed puberty were associated with low BMD.²⁵ BMI and BMI z-scores were associated with BMAD z-scores. Despite a lower BMI being a risk factor for low BMD, two cases of severe osteoporosis were reported in teenage boys with healthy weight (hip BMD z-scores: −4.1 to −4.6).^{59 87}

In the one study that compared BMD z-scores in ARFID to HC, individuals with ARFID had significantly lower BMD z-scores in Total body (−1.41 vs −0.5; $p=0.021$) and total body less head (−1.67 vs −0.74; $p=0.055$); however, in the lumbar spine the difference not significant (−0.95 vs −0.67).²²

Two studies compared BMD z-scores in ARFID to AN. One study found that individuals with ARFID had lower BMD z-scores in their lumbar spine than those with AN

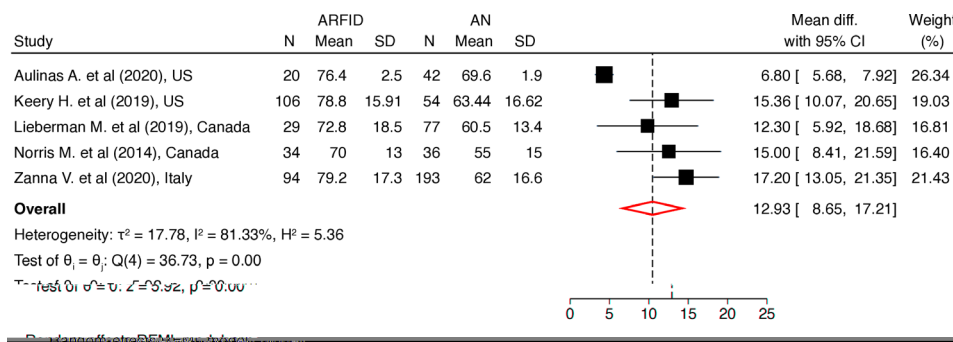


Figure 4 Forest plot showing weighted mean difference in heart rates (beats per minute) between ARFID ($n=283$) and AN ($n=402$). 95% CIs and study weights and indicated. The overall effect size was calculated using a random effects model. AN, anorexia nervosa; ARFID, avoidant restrictive food intake disorder.

(−2.00 vs −1.38, ARFID vs AN, $p < 0.001$).²⁴ Another study reported that although scores were low in both ARFID and AN (−1.88±0.91 and −1.43±1.18, respectively), there was no significant difference between the two.²⁵

Nutritional deficiency

We found 34 studies mentioning micronutrient levels in ARFID (online supplemental table 1).^{15 43 50 52–54 57–59 69 70 72 80–100} However, only two studies compared dietary nutritional content in ARFID to HC^{15 94} and one study to AN.⁹⁶

Five studies contained detailed data on the dietary nutritional content in ARFID; all of which reported a high prevalence of individuals with ARFID not eating the daily recommended intake (DRI) of several micronutrients.^{15 52 53 94 96} One study found that 67% of individuals with ARFID consumed <80% of the DRI of six or more micronutrients.⁵² Furthermore, our searches identified 22 individuals with ARFID suffering from severe micronutritional deficiencies which led to clinical disorders: xerophthalmia due to vitamin A deficiency^{86 87 90 99}; nutritional optic neuropathy due to vitamin B12 and folate deficiency^{87 91}; Wernicke encephalopathy due to vitamin B12 deficiency⁴³; severe osteoporosis due to vitamin D and/or vitamin B12 deficiencies^{59 80 81 84 87}; scurvy due to vitamin C deficiency^{52 70 80 84}; pulmonary artery hypertension from vitamin C deficiency⁷⁰; rickets due to vitamin D deficiency⁸¹ and iron deficiency anaemia.^{72 80 83 90 91 93 95 97}

In comparison to HC, a higher percentage of individuals with ARFID were not meeting the DRI and were consuming a lower percentage of the DRI in almost all micronutrients tested.^{15 94} In contrast, individuals with ARFID consumed less of some micronutrients, such as vitamin C and A, than those with AN but more of others, such as selenium and magnesium.⁹⁶

Puberty and menstruation

We identified 13 studies containing data on puberty and menstruation in ARFID (online supplemental table 1).^{8 9 22 29 33 36 38 62 63 67 75 76 101} Six studies compared pubertal and menstrual measurements in ARFID to AN,^{8 9 29 33 36 38} and three compared them to HC.^{8 9 22}

Amenorrhea (primary and secondary) prevalence was reported at around 10% in females with ARFID.^{33 75} Where menstruation data in women with ARFID were compared with those with AN, all studies found significantly more individuals with AN experienced problems with their menstrual cycles, such as a higher prevalence of amenorrhea and more irregular periods, despite similar BMIs.^{8 29 33 36}

Pubertal data were reported in three studies; however, all three included participants recruited from the same pool. One study reported that age at menarche in ARFID was older than in HC (13.1 and 12.7 years, respectively); however, this was not statistically significant.⁸ In contrast, age at menarche in AN was similar to ARFID (13.2 years). Two of the three studies reported that individuals with ARFID were at significantly lower Tanner stages in

breast and pubic hair development than AN and HC.^{8 9} However, the individuals with ARFID were significantly younger than the HC, and those with AN. Therefore, the differences in Tanner stage and age at menarche were most likely due to the age difference. In contrast, the final study, which contained individuals with ARFID who were of similar ages to the HCs, found that they were at similar breast and pubic hair tanner stages to those HCs.²²

Other physical complications

We found 21 studies that reported physical health complications associated with ARFID, which did not fit into the previously described categories (online supplemental table 1).^{32 39 58 60 61 67 72–74 97 98 102 103}

The prevalence of electrolyte abnormalities in ARFID was reported to be between 23.1% and 73.7%,^{32 39 73} with one study reporting that 23.1% of individuals with ARFID had hypokalaemia and 7.7% had hypophosphatemia.³² Other electrolyte abnormalities mentioned across studies were hypochloreaemia and elevated bicarbonate.^{32 58 67 72} Furthermore, in one case of ARFID in a 3-year-old boy, his hypokalaemia was so severe it led to rhabdomyolysis.⁵⁸ Another study found that significantly more individuals with ARFID had electrolyte abnormalities than those with AN (23% and 10% respectively, $p = 0.03$).³⁹

Several other common physical complications associated with lowweight and EDs were reported in ARFID, such as lanugo, lethargy, dizziness, syncope, pale skin, muscle wasting, dehydration, cognitive problems, headaches, hypothermia, diarrhoea and constipation.^{60 61 72 76 97 98} One study found that 93 out of 207 (44.9%) CYP with ARFID had one or more of these medical symptoms associated with their ED.⁷⁶ Furthermore, some severe, but rare, conditions associated with ARFID, such as Ogilvie's syndrome, hypoalbuminemia and superior mesenteric artery syndrome, were reported by included studies, but the prevalence rates remain unknown.^{60 67 72 74}

DISCUSSION

In this systematic review, we have synthesised the current evidence for physical health complications in ARFID, providing important information for clinicians working with CYP with ARFID. We found evidence for several physical health complications commonly associated with undernutrition to be present in ARFID, such as low weight, nutritional deficiencies and low BMD. We found many studies reporting individuals with ARFID at healthy weight or overweight, which is an important observation and highlights that ARFID is not an exclusively low-weight ED, and individuals can present across the weight spectrum. This has important relevance to clinicians, especially where gateways into ED services can be on weight-based criteria.

We pooled studies for meta-analysis to compare weight status between ARFID and HC, and ARFID and AN, and HRs differences between ARFID and AN. However, high levels of heterogeneity in these analyses (I^2 : 79.8, 86.6%,

and 81.3%, respectively) introduce complexity and are an important limitation for their interpretation,¹⁰⁴ even though we applied random effects models. The high levels of heterogeneity are not a surprise given that the majority of studies were retrospective, variables extracted were not necessarily primary outcomes and most data came from clinical samples with likely non-standardised approaches to measuring anthropometrics as well as pulse rates (eg, some studies did this using electrocardiograms while others did this manually). That said, in the HR analysis the removal of one study⁸ in sensitivity analysis hugely reduced heterogeneity without affecting overall WMD, which is reassuring for the validity of the findings of higher HRs in ARFID versus AN, and remains consistent with all of other studies included in the review. We examined for potential effects on heterogeneity using consistently reported factors such as age and percentage female using meta-regression and found no significance. This all calls for prospective, standardised approaches to measurement of anthropometry and other recognised risk factors, including in clinical settings where important routinely collected data in clinical populations can be collated for analysis.

We found little evidence for the impact of ARFID on growth and puberty, though we would still advocate for monitoring growth and development in CYP with ARFID given the nutritional concerns and the known association between nutrition and growth.¹⁰⁵ Further investigation into the impact on growth, especially longitudinally is needed. We found evidence for micronutrient deficiencies (in some cases associated with very serious complications), electrolyte abnormalities and low BMD in ARFID, all of which did not necessarily discriminate based on the patient's weight (though low BMD was found to be associated with lower BMI status). Some of the most severe cases of micronutrient deficiencies and low BMD were reported in individuals of healthy or overweight status. Therefore, detailed dietetic assessments and physical health assessments should be considered when assessing CYP with ARFID, alongside and irrespective of weight and height measurements.

Most studies of ARFID in CYP reported HRs and BPs to be in normal ranges, (although some did have bradycardia and hypotension) and, as discussed above, our meta-analysis suggests higher HRs in ARFID versus AN in the context of no difference in weight status between participants in included studies. Put together, these are important comparative findings, given the well-known association of starvation in AN and bradycardia.¹⁰⁶ One possible explanation for the greater HR in ARFID versus AN could be that CYP with ARFID tend to be younger than those with AN,² and pulse rates are on average are higher at younger ages.¹⁰⁷ That said, in meta-regression we found no association between age or age difference and effect size. In contrast, one study found that the difference in HR between AN and ARFID was no longer significant after correcting for age.⁸ We hypothesise that differences in HR between ARFID and AN, despite

similar levels of underweight, may be moderated by the often more chronic nature of underweight in ARFID.¹⁰⁸ This is supported by a surveillance study, which reported that CYP with ARFID presenting with more rapid weight loss and a shorter duration of illness were more likely to have a low HR.⁷⁷ While we did not find published studies in our searches reporting deaths from ARFID or mortality analyses such as those found for AN,¹⁰⁹ risk of death from malnutrition is very real¹⁰⁹ and ARFID has been reported as cause of death in a child.¹¹⁰ As we have outlined, ARFID carries the potential for significant and profound physical complications and so here we call for multi-agency vigilance and attention to physical risk. That said, our findings also raise questions about the suitability of using AN exclusively as a model for physical health risk in ARFID,¹¹¹ and highlight the need to design risk-based assessment approaches and protocols that are inclusive of all types of EDs.¹⁰⁵ A nuanced and balanced approach to risk in the context of chronicity for when and why to admit in ARFID in relation to weight status would be of value given the common association with neurodevelopmental problems,¹¹² which themselves are known to carry greater risk for distress and trauma related to hospitalisation.¹¹³

Our review has strengths and limitations. We used systematic searching by two independent researchers across a broad range of databases. This ensured a wide net to catch all the published studies on any physical health complication in ARFID. Consequently, creating a comprehensive guide to the physical health complications associated with ARFID. Studies included in our meta-analyses were all observational studies and mostly scored similarly in quality assessments. However, we also ran sensitivity analyses, removing the poorest quality studies and study outliers based on samples and methodology. We have already commented on the limitations of high levels of heterogeneity in our meta-analysis. Further to this, a key limitation of our review is that most studies found were small, clinical samples rather than population-based, which may have accounted for the wide prevalence estimates for many physical health complications. We found only five studies on true community samples^{17 21 51 55 95} and six from general paediatric clinical settings.^{12 18 48 76 77 103}

Given the relatively new status of ARFID as a diagnosis, it is perhaps not surprising that many studies are of pragmatic, clinical samples from ED services. However, we emphasise the need for more representative samples, such as population-based studies or at least those seen by General Practitioners or paediatricians, rather than just specialist ED teams. Many of the included studies were also cross-sectional, with few studies identified describing longitudinal changes in physical parameters. This is especially important for understanding the impact on growth and development, with growth faltering being a key consideration in underweight CYP.¹¹⁴ Therefore, longitudinal studies should be a high priority to investigate ARFID's long- and short-term risks.

In summary, our systematic review has highlighted the broad range of important physical health complications in ARFID, emphasising a need for comprehensive physical health assessments of CYP with ARFID. We have shown that these complications do not always discriminate based on weight, which has implications for gate-keeping access to services based on low-weight cut-offs alone. This review has also highlighted many gaps in the literature regarding the physical impacts of ARFID, particularly a need for more longitudinal growth data. Finally, our review has emphasised important similarities and differences between ARFID and AN, which should be considered in the approach to patients with EDs in the assessment and treatment of physical risk.

Contributors RMJ co-designed the review, wrote the research protocol (and registered with PROSPERO), performed searches, extracted data, performed analyses, and produced the first draft of the paper as part of her PhD thesis. LDH conceived and co-designed the review, supervised screening and data collection, provided adjudication for study inclusion where RMJ and JO disagreed, supervised analyses, supported the first draft, and critically reviewed and revised the manuscript into its final submitted form. JO performed searches, extracted data and contributed to the final paper as submitted. SR and NM co-designed the review, supported the first draft, critically reviewed and revised the manuscript into its final submitted form. All authors contributed to and approved the final manuscript as submitted and agree to be accountable for all aspects of the work. RMJ is the guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; internally peer reviewed.

Data availability statement Data sharing is not applicable to this article as no new data were created in this study, and all analysed data are included in this published article and the supplementary table.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Rachel Marie James <http://orcid.org/0009-0001-6135-7324>

Jonathan O'Shea <http://orcid.org/0009-0007-5187-2465>

Nadia Micali <http://orcid.org/0000-0001-5571-2273>

Simon J Russell <http://orcid.org/0000-0001-9447-1169>

Lee D Hudson <http://orcid.org/0000-0003-0883-8791>

REFERENCES

- 1 First MB. Diagnostic and statistical manual of mental disorders, 5th edition, and clinical utility. *J Nerv Ment Dis* 2013;201:727–9.

- 2 Bourne L, Bryant-Waugh R, Cook J, *et al*. Avoidant/restrictive food intake disorder: a systematic scoping review of the current literature. *Psychiatry Res* 2020;288:112961.
- 3 Brigham KS, Manzo LD, Eddy KT, *et al*. Evaluation and treatment of avoidant/restrictive food intake disorder (ARFID) in adolescents. *Curr Pediatr Rep* 2018;6:107–13.
- 4 Alderman H, Hoddinott J, Kinsey B. Long term consequences of early childhood malnutrition. *Oxford Economic Papers* 2006;58:450–74.
- 5 Nitsch A, Knopf E, Manwaring J, *et al*. Avoidant/restrictive food intake disorder (ARFID): its medical complications and their treatment—an emerging area. *Curr Pediatr Rep* 2021;9:21–9.
- 6 Moher D, Liberati A, Tetzlaff J, *et al*. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009;339:b2535.
- 7 Sterne JAC, Sutton AJ, Ioannidis JPA, *et al*. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. *BMJ* 2011;343:d4002.
- 8 Aulinas A, Marengi DA, Galbiati F, *et al*. Medical comorbidities and endocrine dysfunction in low-weight females with avoidant/restrictive food intake disorder compared to anorexia nervosa and healthy controls. *Int J Eat Disord* 2020;53:631–6.
- 9 Becker KR, Mancuso C, Dreier MJ, *et al*. Ghrelin and PYY in low-weight females with avoidant/restrictive food intake disorder compared to anorexia nervosa and healthy controls. *Psychoneuroendocrinology* 2021;129.
- 10 Izquierdo A, Plessow F, Becker KR, *et al*. Implicit attitudes toward dieting and thinness distinguish fat-phobic and non-fat-phobic anorexia nervosa from avoidant/restrictive food intake disorder in adolescents. *Int J Eat Disord* 2019;52:419–27.
- 11 Eddy KT, Thomas JJ, Hastings E, *et al*. Prevalence of DSM-5 avoidant/restrictive food intake disorder in a pediatric gastroenterology healthcare network. *Int J Eat Disord* 2015;48:464–70.
- 12 Murray HB, Rao FU, Baker C, *et al*. Prevalence and characteristics of avoidant/restrictive food intake disorder in pediatric neurogastroenterology patients. *J Pediatr Gastroenterol Nutr* 2022;74:588–92.
- 13 Murray HB, Becker KR, Harshman S, *et al*. Elevated fasting satiety-promoting cholecystokinin (CCK) in avoidant/restrictive food intake disorder compared to healthy controls. *J Clin Psychiatry* 2022;83:41767.
- 14 Cañas L, Palma C, Molano AM, *et al*. Avoidant/restrictive food intake disorder: psychopathological similarities and differences in comparison to anorexia Nervosa and the general population. *Eur Eat Disord Rev* 2021;29:245–56.
- 15 Schmidt R, Hiemisch A, Kiess W, *et al*. Macro- and micronutrient intake in children with avoidant/restrictive food intake disorder. *Nutrients* 2021;13:400.
- 16 Schmidt R, Hiemisch A, Kiess W, *et al*. Validation study on the child, adult, and parent version of the ARFID module 2.0 for the eating disorder examination. *Int J Eat Disord* 2022;55:1708–20.
- 17 Schmidt R, Kirsten T, Hiemisch A, *et al*. Interview-based assessment of avoidant/restrictive food intake disorder (ARFID): a pilot study evaluating an ARFID module for the eating disorder examination. *Int J Eat Disord* 2019;52:388–97.
- 18 Schöffel H, Hiemisch A, Kiess W, *et al*. Characteristics of avoidant/restrictive food intake disorder in a general paediatric inpatient sample. *Eur Eat Disord Rev* 2021;29:60–73.
- 19 Zanna V, Criscuolo M, Mereu A, *et al*. Restrictive eating disorders in children and adolescents: a comparison between clinical and psychopathological profiles. *Eat Weight Disord* 2021;26:1491–501.
- 20 Wilken M, Hesse M, Jockenhöfer A, *et al*. Are feeding disorders and feeding tube dependency the same?: a discrimination study between feeding disorders, feeding tube dependency and healthy eaters. *J Paediatr Child Health* 2022;58:63–8.
- 21 Dovey TM, Kumari V, Blissett J, *et al*. Eating behaviour, behavioural problems and sensory profiles of children with avoidant/restrictive food intake disorder (ARFID), autistic spectrum disorders or picky eating: same or different. *Eur Psychiatry* 2019;61:56–62.
- 22 Sella AC, Becker KR, Slattery M, *et al*. Low bone mineral density is found in low weight female youth with avoidant/restrictive food intake disorder and associated with higher PYY levels. *J Eat Disord* 2023;11:106.
- 23 Datta N, Lock JD. Exploration of Interoceptive capabilities in avoidant/restrictive food intake disorder and anorexia nervosa. *J Eat Disord* 2023;11:189.
- 24 Norris ML, Robinson A, Obeid N, *et al*. Exploring avoidant/restrictive food intake disorder in eating disordered patients: a descriptive study. *Int J Eat Disord* 2014;47:495–9.

- 25 Alberts Z, Fewtrell M, Nicholls DE, *et al.* Bone mineral density in anorexia nervosa versus avoidant restrictive food intake disorder. *Bone* 2020;134:115307.
- 26 Breithaupt L, Kahn DL, Slattery M, *et al.* Eighteen-month course and outcome of adolescent restrictive eating disorders: persistence, crossover, and recovery. *J Clin Child Adolesc Psychol* 2022;51:715–25.
- 27 Fisher M, Gonzalez M, Malizio J. Eating disorders in adolescents: how does the DSM-5 change the diagnosis? *Int J Adolesc Med Health* 2015;27:437–41.
- 28 Ornstein RM, Rosen DS, Mammel KA, *et al.* Distribution of eating disorders in children and adolescents using the proposed DSM-5 criteria for feeding and eating disorders. *J Adolesc Health* 2013;53:303–5.
- 29 Forman SF, McKenzie N, Hehn R, *et al.* Predictors of outcome at 1 year in adolescents with DSM-5 restrictive eating disorders: report of the national eating disorders quality improvement collaborative. *J Adolesc Health* 2014;55:750–6.
- 30 Bryson AE, Scipioni AM, Essayli JH, *et al.* Outcomes of low-weight patients with avoidant/restrictive food intake disorder and anorexia nervosa at long-term follow-up after treatment in a partial hospitalization program for eating disorders. *Int J Eat Disord* 2018;51:470–4.
- 31 Lange CRA, Ekedahl Fjertorp H, Holmer R, *et al.* Long-term follow-up study of low-weight avoidant restrictive food intake disorder compared with childhood-onset anorexia nervosa: psychiatric and occupational outcome in 56 patients. *Int J Eating Disorders* 2019;52:435–8.
- 32 Makhzoumi SH, Schreyer CC, Hansen JL, *et al.* Hospital course of underweight youth with ARFID treated with a meal-based behavioral protocol in an inpatient-partial hospitalization program for eating disorders. *Int J Eat Disord* 2019;52:428–34.
- 33 Keery H, LeMay-Russell S, Barnes TL, *et al.* Attributes of children and adolescents with avoidant/restrictive food intake disorder. *J Eat Disord* 2019;7:31:31..
- 34 Kurotori I, Shioda K, Abe T, *et al.* An inpatient observational study: characteristics and outcomes of avoidant/restrictive food intake disorder (ARFID) in children and adolescents in Japan. *Neuropsychiatr Dis Treat* 2019;15:3313–21.
- 35 Lieberman M, Houser ME, Voyer A-P, *et al.* Children with avoidant/restrictive food intake disorder and anorexia nervosa in a tertiary care pediatric eating disorder program: a comparative study. *Int J Eat Disord* 2019;52:239–45.
- 36 Middleman AB, Griffin B, DeShea L. Menstrual patterns among patients with anorexia nervosa and avoidant/restrictive food intake disorder: does “junk food” play a role? *J Pediatr Adolesc Gynecol* 2021;34:811–4.
- 37 Peebles R, Lesser A, Park CC, *et al.* Outcomes of an inpatient medical nutritional rehabilitation protocol in children and adolescents with eating disorders. *J Eat Disord* 2017;5:7:7..
- 38 Tamura A, Minami K, Tsuda Y, *et al.* Characteristics and outcomes of avoidant/restrictive food intake disorder in Japanese elementary-school students on total parenteral nutrition. *Pediatr Investig* 2021;5:293–8.
- 39 Strandjord SE, Sieke EH, Richmond M, *et al.* Avoidant/restrictive food intake disorder: illness and hospital course in patients hospitalized for nutritional insufficiency. *J Adolesc Health* 2015;57:673–8.
- 40 Nicely TA, Lane-Loney S, Masciulli E, *et al.* Prevalence and characteristics of avoidant/restrictive food intake disorder in a cohort of young patients in day treatment for eating disorders. *J Eat Disord* 2014;2:21.
- 41 Norris ML, Santos A, Obeid N, *et al.* Characteristics and clinical trajectories of patients meeting criteria for avoidant/restrictive food intake disorder that are subsequently reclassified as anorexia nervosa. *Eur Eat Disord Rev* 2020;28:26–33.
- 42 Knatz Peck S, Towne T, Wierenga CE, *et al.* Temperament-based treatment for young adults with eating disorders: acceptability and initial efficacy of an intensive, multi-family, parent-involved treatment. *J Eat Disord* 2021;9:110.
- 43 Mahr F, Billman Miller MG, Quail MA, *et al.* Serum zinc levels in youth with avoidant/restrictive food intake disorder and anorexia nervosa: clinical correlation with weight and psychopathology. *Nutr Health* 2023;2601060231191658.
- 44 Mahr F, Miller MGB, Quail MA, *et al.* Neuropsychological profiles and clinical correlates of youths with avoidant/restrictive food intake disorder and anorexia nervosa: an exploratory charter investigation. *J Pediatr Neuropsychol* 2023;9:200–13.
- 45 Dupois D, Brosig L, Hiemisch A, *et al.* Distribution and clinical comparison of restrictive feeding and eating disorders using ICD-10 and ICD-11 criteria. *Int J Eat Disord* 2023;56:1717–29.
- 46 Lucarelli L, Sechi C, Cimino S, *et al.* Avoidant/restrictive food intake disorder: a longitudinal study of malnutrition and psychopathological risk factors from 2 to 11 years of age. *Front Psychol* 2018;9:1608.
- 47 Waddle C, Gillespie SE. Examination of pediatric tube feeding schedules and oral intake: a retrospective cross-sectional study. *Nutr Clin Pract* 2023;38:458–64.
- 48 Eddy KT, Thomas JJ, Hastings E, *et al.* Prevalence of DSM-5 avoidant/restrictive food intake disorder in a pediatric gastroenterology healthcare network. *Int J Eating Disorders* 2015;48:464–70.
- 49 Thomas JJ, Becker KR, Kuhnle MC, *et al.* Cognitive-behavioral therapy for avoidant/restrictive food intake disorder: feasibility, acceptability, and proof-of-concept for children and adolescents. *Int J Eating Disorders* 2020;53:1636–46.
- 50 Brosig L, Dupois D, Hiemisch A, *et al.* Birth-related, medical, and diagnostic characteristics in younger versus older children with avoidant/restrictive food intake disorder (ARFID). *J Eat Disord* 2023;11:190.
- 51 Prasetyo YB. The effects of socio-demographical factors and perceived seriousness upon motherly skill of managing eating disorder on children with avoidant restrictive food intake disorder (ARFID). *J Global Pharma Technol* 2020;12:496–503.
- 52 Sharp WG, Postorino V, McCracken CE, *et al.* Dietary intake, nutrient status, and growth parameters in children with autism spectrum disorder and severe food selectivity. *J Acad Nutr Diet* 2018;118:1943–50.
- 53 Volkert VM, Burrell L, Berry RC, *et al.* Intensive multidisciplinary feeding intervention for patients with avoidant/restrictive food intake disorder associated with severe food selectivity: an electronic health record review. *Int J Eat Disord* 2021;54:1978–88.
- 54 Zickgraf HF, Murray HB, Kratz HE, *et al.* Characteristics of outpatients diagnosed with the selective/neophobic presentation of avoidant/restrictive food intake disorder. *Int J Eat Disord* 2019;52:367–77.
- 55 Dinkler L, Yasumitsu-Lovell K, Eitoku M, *et al.* Development of a parent-reported screening tool for avoidant/restrictive food intake disorder (ARFID): initial validation and prevalence in 4–7-year-old Japanese children. *Appetite* 2022;168:105735.
- 56 Dahlsgaard KK, Bodie J. The (extremely) picky eaters clinic: a pilot trial of a seven-session group behavioral intervention for parents of children with avoidant/restrictive food intake disorder. *Cognitive and Behavioral Practice* 2019;26:492–505.
- 57 Becker KR, Breithaupt L, Lawson EA, *et al.* Co-occurrence of avoidant/restrictive food intake disorder and traditional eating psychopathology. *J Am Acad Child Adolesc Psychiatry* 2020;59:209–12.
- 58 Cao LL, Gaffney LK, Marcus C. Hypokalemia-induced rhabdomyolysis in a child with autism affected by the COVID-19 pandemic. *J Dev Behav Pediatr* 2022;43:e356–60.
- 59 Chandran JJ, Anderson G, Kennedy A, *et al.* Subacute combined degeneration of the spinal cord in an adolescent male with avoidant/restrictive food intake disorder: a clinical case report. *Int J Eat Disord* 2015;48:1176–9.
- 60 Katsumi Y, Kodo K, Goto S. Case report: COVID-19 pandemic exacerbates eating disorder by social and intrafamilial isolation. *Front Pediatr* 2022;10:819214.
- 61 Katzman DK, Stevens K, Norris M. Redefining feeding and eating disorders: what is avoidant/restrictive food intake disorder. *Paediatr Child Health* 2014;19:445–6.
- 62 Milligan T, Middleman AB. Facing an eating disorder: a case of body dysmorphic disorder and avoidant/restrictive food intake disorder. *SAGE Open Med Case Rep* 2022;10:2050313X221111679.
- 63 Naviaux A-F. Management of ARFID (avoidant restrictive food intake disorder) in a 12-year-old on a paediatric ward in a general hospital: use of mirtazapine, partial hospitalisation model and family based therapy. *Psychiatr Danub* 2019;31:421–6.
- 64 Rienecke RD, Drayton A, Richmond RL, *et al.* Adapting treatment in an eating disorder program to meet the needs of patients with ARFID: three case reports. *Clin Child Psychol Psychiatry* 2020;25:293–303.
- 65 Reid DB. A case study of hypnosis for phagophobia: it's no choking matter. *Am J Clin Hypn* 2016;58:357–67.
- 66 Soffritti EM, Lomar Passos BC, Rodrigues GA, *et al.* Adult avoidant/restrictive food intake disorder: a case report. *J Bras Psiquiatr* 2020;68:252–7.
- 67 Thomas JJ, Brigham KS, Sally ST, *et al.* Case 18-2017—an 11-year-old girl with difficulty eating after a choking incident. *N Engl J Med* 2017;376:2377–86.

- 68 Yaşar AB, Abamor AE, Usta FD, *et al.* Two cases with avoidant/restrictive food intake disorder (ARFID): effectiveness of EMDR and CBT combination on eating disorders (ED). *J Clin Psy* 2019;22:493–500.
- 69 Basouny N, Spigos J, Khvolis D, *et al.* Wernicke encephalopathy in a pediatric patient with avoidant restrictive food intake disorder: a rare presentation of thiamine deficiency. *Am J Case Rep* 2023;24:e940717.
- 70 Quinn LA, Gilley SP, Ta AD, *et al.* Case report: pulmonary hypertensive crisis leading to cardiac arrest during endoscopic evaluation in a 6-year-old boy with autism, severe malnutrition, and undiagnosed scurvy. *Front Pediatr* 2022;10:1008507.
- 71 Cooney M, Lieberman M, Guimond T, *et al.* Clinical and psychological features of children and adolescents diagnosed with avoidant/restrictive food intake disorder in a pediatric tertiary care eating disorder program: a descriptive study. *J Eat Disord* 2018;6:7.
- 72 Bertrand V, Dhenin C, Déchelotte P, *et al.* Delayed avoidant restrictive food intake disorder diagnosis leading to Ogilvie's syndrome in an adolescent. *Eat Weight Disord* 2022;27:1913–8.
- 73 Tsang KK, Hayes LC, Bujoreanu S, *et al.* Characterization study of patients presenting to an acute care pediatric hospital identified with avoidant/restrictive food intake disorder. *Hosp Pediatr* 2020;10:600–7.
- 74 Yazdani S, Bloomberg Z, Klauber R, *et al.* Avoidant restrictive food intake disorder emerging during COVID-19 pandemic resulting in superior mesenteric artery syndrome. *Eat Weight Disord* 2022;27:2943–5.
- 75 Duncombe Lowe K, Barnes TL, Martell C, *et al.* Youth with avoidant/restrictive food intake disorder: examining differences by age, weight status, and symptom duration. *Nutrients* 2019;11:1955.
- 76 Katzman DK, Spettigue W, Agostino H, *et al.* Incidence and age- and sex-specific differences in the clinical presentation of children and adolescents with avoidant restrictive food intake disorder. *JAMA Pediatr* 2021;175:e213861.
- 77 Katzman DK, Guimond T, Spettigue W, *et al.* Classification of children and adolescents with avoidant/restrictive food intake disorder. *Pediatrics* 2022;150:e2022057494.
- 78 Norris ML, Spettigue W, Hammond NG, *et al.* Building evidence for the use of descriptive subtypes in youth with avoidant restrictive food intake disorder. *Int J Eat Disord* 2018;51:170–3.
- 79 Schermbucker J, Kimber M, Johnson N, *et al.* Avoidant/restrictive food intake disorder in an 11-year old South American boy: medical and cultural challenges. *J Can Acad Child Adolesc Psychiatry* 2017;26:110–3.
- 80 Kim GC, Davidson AM, Beyda RM, *et al.* Scurvy, abnormal MRI, and gelatinous bone marrow in an adolescent with avoidant restrictive food intake disorder. *J Eat Disord* 2023;11:41.
- 81 Islam N, Hathaway KL, Anderson BS, *et al.* Brief report: decreased bone health in children with autism spectrum disorder and avoidant restrictive food intake disorder. *J Autism Dev Disord* 2023;1–7.
- 82 Gorrell S, Vendlinski SS, Thompson AS, *et al.* Modification of an inpatient medical management protocol for pediatric avoidant/restrictive food intake disorder: improving the standard of care. *J Eat Disord* 2023;11:165.
- 83 Yanagimoto Y, Ishizaki Y, Kaneko K. Iron deficiency anemia, stunted growth, and developmental delay due to avoidant/restrictive food intake disorder by restricted eating in autism spectrum disorder. *Biopsychosoc Med* 2020;14:8.
- 84 Benezech S, Hartmann C, Morfin D, *et al.* Is it leukemia, doctor? No, it's scurvy induced by an ARFID! *Eur J Clin Nutr* 2020;74:1247–9.
- 85 Hadwiger AN, Middleman AB, Pitt PD. Case series: gaming vs. eating—comorbidity of ARFID and IGD. *Eat Weight Disord* 2019;24:959–62.
- 86 Mahoney GL, Larcombe PJ, Ling J, *et al.* Vitamin A deficiency in avoidant restrictive food intake disorder. *J Paediatr Child Health* 2022;58:1899–900.
- 87 Mina J-A, Greeff S. The'll'n nutrition: paediatric nutritional optic neuropathy secondary to avoidant/restrictive food intake disorder and multi-micronutrient deficiency. *J Paediatr Child Health* 2022;58:1672–3.
- 88 Richmond TK, Carmody J, Freizinger M, *et al.* Assessment of patients with ARFID presenting to multi-disciplinary tertiary care program. *J Pediatr Gastroenterol Nutr* 2023;76:743–8.
- 89 Alten ED, Chaturvedi A, Cullimore M, *et al.* No longer a historical ailment: two cases of childhood scurvy with recommendations for bone health providers. *Osteoporos Int* 2020;31:1001–5.
- 90 Barney A, Bruett LD, Forsberg S, *et al.* Avoidant restrictive food intake disorder (ARFID) and body image: a case report. *J Eat Disord* 2022;10:61.
- 91 Chiarello F, Marini E, Ballerini A, *et al.* Optic neuropathy due to nutritional deficiency in a male adolescent with avoidant/restrictive food intake disorder: a case report. *Eat Weight Disord* 2018;23:533–5.
- 92 Cuttin K, Neri C, Tang M, *et al.* Social determinants of health and the role of routine pediatric care in a medically complex toddler. *J Dev Behav Pediatr* 2020;41:583–5.
- 93 Dolman L, Thornley S, Doxtator K, *et al.* Multimodal therapy for rigid, persistent avoidant/restrictive food intake disorder (ARFID) since infancy: a case report. *Clin Child Psychol Psychiatry* 2021;26:451–63.
- 94 Harshman SG, Wons O, Rogers MS, *et al.* A diet high in processed foods, total carbohydrates and added sugars, and low in vegetables and protein is characteristic of youth with avoidant/restrictive food intake disorder. *Nutrients* 2019;11:2013.
- 95 Nygren G, Linnsand P, Hermansson J, *et al.* Feeding problems including avoidant restrictive food intake disorder in young children with autism spectrum disorder in a multiethnic population. *Front Pediatr* 2021;9:780680.
- 96 Santiago A, Zimmerman J, Feinstein R, *et al.* Diet quality of adolescents with eating disorders. *Int J Adolesc Med Health* 2017;31:20170033.
- 97 Lim TSH, Aw M, Slosky L, *et al.* Beyond picky eating. *J Dev Behav Pediatr* 2020;41:656–8.
- 98 Taylor T. Increasing food texture and teaching chewing for a clinical case within the home setting in Australia. *Learning and Motivation* 2020;71:101651.
- 99 Dean M, Selvarajan L, Fernandez D, *et al.* G15 irreversible blindness in two children with autism spectrum disorder. *Frontline Gastroenterol* 2022;13:A26–7.
- 100 Watts R, Archibald T, Hembry P, *et al.* The clinical presentation of avoidant restrictive food intake disorder in children and adolescents is largely independent of sex, autism spectrum disorder and anxiety traits. *EClinicalMedicine* 2023;63:102190.
- 101 Pitt PD, Middleman AB. A focus on behavior management of avoidant/restrictive food intake disorder (ARFID): a case series. *Clin Pediatr (Phila)* 2018;57:478–80.
- 102 Bergonzini L, Pruccoli J, Parmeggiani A. Avoidant-restrictive food intake disorder in a male patient with Goldenhar syndrome. *Eat Weight Disord* 2022;27:3803–7.
- 103 Boerner KE, Coelho JS, Syal F, *et al.* Pediatric avoidant-restrictive food intake disorder and gastrointestinal-related somatic symptom disorders: overlap in clinical presentation. *Clin Child Psychol Psychiatry* 2022;27:385–98.
- 104 Imrey PB. Limitations of meta-analyses of studies with high heterogeneity. *JAMA Netw Open* 2020;3:e1919325.
- 105 Hudson LD, Chapman S. *Paediatric medical care for children and young people with eating disorders: achievements and where to next.* London, England: SAGE Publications Sage UK, 2020:716–20.
- 106 Sachs KV, Harnke B, Mehler PS, *et al.* Cardiovascular complications of anorexia nervosa: a systematic review. *Int J Eat Disord* 2016;49:238–48.
- 107 Fleming S, Thompson M, Stevens R, *et al.* Normal ranges of heart rate and respiratory rate in children from birth to 18 years of age: a systematic review of observational studies. *The Lancet* 2011;377:1011–8.
- 108 Fisher MM, Rosen DS, Ornstein RM, *et al.* Characteristics of avoidant/restrictive food intake disorder in children and adolescents: a "new disorder" in DSM-5. *J Adolesc Health* 2014;55:49–52.
- 109 Rice AL, Sacco L, Hyder A, *et al.* Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. *Bull World Health Organ* 2000;78:1207–21.
- 110 Mutch A. *Alfie Nicholls: prevention of future deaths report.* Courts and Tribunals Judiciary, 2024.
- 111 Isner JM, Roberts WC, Heymsfield SB, *et al.* Anorexia nervosa and sudden death. *Ann Intern Med* 1985;102:49–52.
- 112 Dinkler L, Yasumitsu-Lovell K, Eitoku M, *et al.* Early neurodevelopmental problems and risk for avoidant/restrictive food intake disorder (ARFID) in 4-7-Year-Old children: a Japanese birth cohort study. *JCPP Adv* 2022;2:e12094.
- 113 McGuire K, Erickson C, Gabriels RL, *et al.* Psychiatric hospitalization of children with autism or intellectual disability: consensus statements on best practices. *J Am Acad Child Adolesc Psychiatry* 2015;54:969–71.
- 114 Neale J, Pais SMA, Nicholls D, *et al.* What are the effects of restrictive eating disorders on growth and puberty and are effects permanent? A systematic review and meta-analysis. *J Adolesc Health* 2020;66:144–56.

- 115 Bąbik K, Ostaszewski P, Horvath A, *et al.* Nutritional versus behavioural intervention in children with avoidant/restrictive food intake disorder. *Psychiatr Psychol Kli* 2021;21:3–14.
- 116 Billman MG, Forrest LN, Johnson M, *et al.* Preliminary effectiveness of a cognitive-behavioral, family-centered partial hospitalization program for children and adolescents with avoidant/restrictive food intake disorder. *Int J Eat Disord* 2022;55:1621–6.
- 117 Brewerton TD, D'Agostino M. Adjunctive use of olanzapine in the treatment of avoidant restrictive food intake disorder in children and adolescents in an eating disorders program. *J Child Adolesc Psychopharmacol* 2017;27:920–2.
- 118 Brown M, Hildebrandt T. Parent-facilitated behavioral treatment for avoidant/restrictive food intake disorder: a case report. *Cognitive and Behavioral Practice* 2020;27:231–51.
- 119 Bryant-Waugh R. Avoidant restrictive food intake disorder: an illustrative case example. *Int J Eat Disord* 2013;46:420–3.
- 120 Buleza KA, Mathews N, Curran KA, *et al.* A weighty issue: refeeding an adolescent patient on dialysis. *Eat Weight Disord* 2021;26:739–41.
- 121 Burton C, Allan E, Eckhardt S, *et al.* Case presentations combining family-based treatment with the unified protocols for transdiagnostic treatment of emotional disorders in children and adolescents for comorbid avoidant restrictive food intake disorder and autism spectrum disorder. *J Can Acad Child Adolesc Psychiatry* 2021;30:280–91.
- 122 Burton Murray H, Becker KR, Breithaupt L, *et al.* Food neophobia as a mechanism of change in video-delivered cognitive-behavioral therapy for avoidant/restrictive food intake disorder: a case study. *Int J Eat Disord* 2022;55:1156–61.
- 123 Chatoor I, Begtrup R, Cheng IY, *et al.* Failure to thrive in toddlers with lack of interest in eating and food and their cognitive development during later childhood. *Front Pediatr* 2023;11:1179797.
- 124 Datta N, Matheson B, Walker AC, *et al.* Psychoeducational and motivational treatment for low-weight avoidant/restrictive food intake disorder (ARFID): three case reports in school-aged children. *Clin Child Psychol Psychiatry* 2023;28:1123–34.
- 125 Dolan SC, Kambanis PE, Stern CM, *et al.* Anticipatory and consummatory pleasure in avoidant/restrictive food intake disorder. *J Eat Disord* 2023;11:198.
- 126 Dumont E, Jansen A, Kroes D, *et al.* A new cognitive behavior therapy for adolescents with avoidant/restrictive food intake disorder in a day treatment setting: a clinical case series. *Int J Eat Disord* 2019;52:447–58.
- 127 Finn DM, Menzel JE, Gray E, *et al.* Pharmacotherapy for attention deficit/hyperactivity disorder in youth with avoidant restrictive food intake disorder: a case series of patients prescribed stimulant medication in a partial hospitalization program for eating disorders. *J Eat Disord* 2023;11:226.
- 128 Gray E, Chen T, Menzel J, *et al.* Mirtazapine and weight gain in avoidant and restrictive food intake disorder. *J Am Acad Child Adolesc Psychiatry* 2018;57:288–9.
- 129 Izquierdo A, Plessow F, Becker KR, *et al.* Implicit attitudes toward dieting and thinness distinguish fat-phobic and non-fat-phobic anorexia nervosa from avoidant/restrictive food intake disorder in adolescents. *Int J Eat Disord* 2019;52:419–27.
- 130 Kerem L, Van De Water AL, Kuhnle MC, *et al.* Neurobiology of avoidant/restrictive food intake disorder in youth with overweight/obesity versus healthy weight. *J Clin Child Adolesc Psychol* 2022;51:701–14.
- 131 Calisan Kinter R, Ozbaran B, Inal Kaleli I, *et al.* The sensory profiles, eating behaviors, and quality of life of children with autism spectrum disorder and avoidant/restrictive food intake disorder. *Psychiatr Q* 2024;95:85–106.
- 132 Krom H, van der Sluijs Veer L, van Zundert S, *et al.* Health related quality of life of infants and children with avoidant restrictive food intake disorder. *Int J Eat Disord* 2019;52:410–8.
- 133 Krom H, van Oers HA, van der Sluijs Veer L, *et al.* Health-related quality of life and distress of parents of children with avoidant restrictive food intake disorder. *J Pediatr Gastroenterol Nutr* 2021;73:115–24.
- 134 Lane-Loney SE, Zickgraf HF, Ornstein RM, *et al.* A cognitive-behavioral family-based protocol for the primary presentations of avoidant/restrictive food intake disorder (ARFID): case examples and clinical research findings. *Cogn Behav Pract* 2022;29:318–34.
- 135 Lock J, Robinson A, Sadeh-Sharvit S, *et al.* Applying family-based treatment (FBT) to three clinical presentations of avoidant/restrictive food intake disorder: similarities and differences from FBT for anorexia nervosa. *Int J Eat Disord* 2019;52:439–46.
- 136 Lock J, Sadeh-Sharvit S, L'Insalata A. Feasibility of conducting a randomized clinical trial using family-based treatment for avoidant/restrictive food intake disorder. *Int J Eat Disord* 2019;52:746–51.
- 137 Lu ZA, Mu W, Osborne LM, *et al.* Eighteen-year-old man with autism, obsessive compulsive disorder and a SHANK2 variant presents with severe anorexia that responds to high-dose fluoxetine. *BMJ Case Rep* 2018;2018:bcr2018225119.
- 138 Maertens C, Couturier J, Grant C, *et al.* Fear of vomiting and low body weight in two pediatric patients: diagnostic challenges. *J Can Acad Child Adolesc Psychiatry* 2017;26:59–61.
- 139 Mahr F, Billman M, Essayli JH, *et al.* Selective serotonin reuptake inhibitors and hydroxyzine in the treatment of avoidant/restrictive food intake disorder in children and adolescents: rationale and evidence. *J Child Adolesc Psychopharmacol* 2022;32:117–21.
- 140 Ornstein RM, Essayli JH, Nicely TA, *et al.* Treatment of avoidant/restrictive food intake disorder in a cohort of young patients in a partial hospitalization program for eating disorders. *Int J Eat Disord* 2017;50:1067–74.
- 141 Rebollo Román Á, Barrera Martín A, Alcántara-Laguna MD, *et al.* Non-oro-pharyngeal dysphagia with frequent emergency room attendance. *Nutr Hosp* 2018;35:996–8.
- 142 Pennell A, Couturier J, Grant C, *et al.* Severe avoidant/restrictive food intake disorder and coexisting stimulant treated attention deficit hyperactivity disorder. *Int J Eat Disord* 2016;49:1036–9.
- 143 Robson J, Laborda T, Fitzgerald S, *et al.* Avoidant/restrictive food intake disorder in diet-treated children with eosinophilic esophagitis. *J Pediatr Gastroenterol Nutr* 2019;69:57–60.
- 144 Rosania K, Lock J. Family-based treatment for a preadolescent with avoidant/restrictive food intake disorder with sensory sensitivity: a case report. *Front Psychiatry* 2020;11:350.
- 145 Schmidt R, Kirsten T, Hiemisch A, *et al.* Interview-based assessment of avoidant/restrictive food intake disorder (ARFID): a pilot study evaluating an ARFID module for the eating disorder examination. *Int J Eat Disord* 2019;52:388–97.
- 146 Shafiq R, Aziz A, Asif G, *et al.* Assessing dietary practices of children with avoidant restrictive food intake disorder (ARFID)-a cross-sectional study. *J Liaq Uni Med Health Sci* 2023;22:179–84.
- 147 Sharp WG, Stubbs KH, Adams H, *et al.* Intensive, manual-based intervention for pediatric feeding disorders: results from a randomized pilot trial. *J Pediatr Gastroenterol Nutr* 2016;62:658–63.
- 148 Sharp WG, Volkert VM, Stubbs KH, *et al.* Intensive multidisciplinary intervention for young children with feeding tube dependence and chronic food refusal: an electronic health record review. *J Pediatr* 2020;223:73–80.
- 149 Shimshoni Y, Silverman WK, Lebowitz ER. SPACE-ARFID: a pilot trial of a novel parent-based treatment for avoidant/restrictive food intake disorder. *Int J Eat Disord* 2020;53:1623–35.
- 150 Spettigue W, Norris ML, Santos A, *et al.* Treatment of children and adolescents with avoidant/restrictive food intake disorder: a case series examining the feasibility of family therapy and adjunctive treatments. *J Eat Disord* 2018;6:20.
- 151 Stubbs KH, McMahon MXH, Popler J, *et al.* Multidisciplinary feeding treatment for a patient with interstitial lung disease. *Pediatric Pulmonology* 2022;57:3183–5.
- 152 Tomioka K, Nishiyama M, Tokumoto S, *et al.* Behavioral therapy for children with avoidant/restrictive food intake disorder dependent on tube or oral enteral nutrient formula: a feasibility study. *Kobe J Med Sci* 2022;67:E155–60.
- 153 Webb J, Dhopatkar N, Croft P, *et al.* Clinical reflections and treatment adaptations for avoidant restrictive food intake disorder: a case study. *Clinical Case Studies* 2023;22:453–67.