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Prevalence and Characterization of Avoidant Restrictive Food Intake Disorder in a Pediatric Population

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Objective: Avoidant/restrictive food intake disorder (ARFID) is a relatively new feeding and eating disorder category in *DSM-5* characterized by extreme food avoidance/restriction. Much is unknown about ARFID, with limited understanding of its prevalence and comorbidities in general pediatric populations. This study aimed to classify ARFID prevalence and characteristics in children within the Generation R Study, a population-based Dutch cohort (N = 2,862).

Method: ARFID was assessed via an Index that comprised parent-reported questionnaires and researcher-assessed measures of picky eating, energy intake, diet quality, growth, and psychosocial impact, all in the absence of body/weight dissatisfaction to align with *DSM-5* criteria. Parents also reported on child appetitive traits and emotional/behavioral problems (eg, anxiety, depression, attention problems).

Results: Using *DSM-5*–based categorization, 183 (6.4%) of 2,862 children were classified as presenting with ARFID symptoms. Compared with children not exhibiting symptoms, children classified with ARFID symptomatology expressed other avoidant eating behavior, including decreased enjoyment of food ($d = -1.06$, false discovery rate–corrected p [p_{FDR}] $< .001$), increased satiety responsiveness ($d = 1.06$, $p_{FDR} < .001$), and emotional undereating ($d = 0.21$, $p_{FDR} < .01$), as well as more emotional problems, including withdrawn/depressed ($d = 0.38$, $p_{FDR} < .001$), social problems ($d = 0.34$, $p_{FDR} < 0.001$), attention problems ($d = 0.38$, $p_{FDR} < .001$), anxiety ($d = 0.30$, $p_{FDR} < .001$), obsessive/compulsive problems ($d = 0.15$, $p_{FDR} < .05$), and autistic traits ($d = 0.22$; $p_{FDR} < .05$). Associations did not differ by sex.

Conclusion: This is the first large-scale community-based study to characterize ARFID and to demonstrate that ARFID symptom classification is common in children aged ≤10 years. Findings suggest that appetitive, emotional, and behavioral comorbidities may underlie or reinforce the presentation of ARFID.

Diversity & Inclusion Statement: We worked to ensure sex and gender balance in the recruitment of human participants. We worked to ensure race, ethnic, and/or other types of diversity in the recruitment of human participants. Diverse cell lines and/or genomic datasets were not available. While citing references scientifically relevant for this work, we also actively worked to promote inclusion of historically underrepresented racial and/or ethnic groups in science in our reference list. The author list of this paper includes contributors from the location and/or community where the research was conducted who participated in the data collection, design, analysis, and/or interpretation of the work. We actively worked to promote sex and gender balance in our author group. One or more of the authors of this paper self-identifies as a member of one or more historically underrepresented sexual and/or gender groups in science.

Key words: ARFID; classification; pediatric; prevalence; symptomatology

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Avoidant/restrictive food intake disorder (ARFID) is a relatively new feeding or eating disorder (FED) that was introduced in *DSM-5*.[1] ARFID is characterized by extreme restriction in dietary intake to the extent that the person's weight, growth, nutritional intake, or psychosocial functioning is significantly impacted, or dependence on nutritional supplements/enteral feeding is required. *DSM-5* criteria also state that poor food intake is not due to lack of food availability or cultural practice and it is not attributed to another mental disorder[1] or other FED such as anorexia nervosa or bulimia nervosa. ARFID is clinically distinct from other FEDs, and importantly symptoms do not stem from weight dissatisfaction or disturbances in body image, with ARFID occurring across the weight spectrum.[2] Compared to individuals with anorexia nervosa or bulimia nervosa, patients with ARFID are more likely to be male,[3–9] to have a younger age of onset,[3,4] and to experience longer duration of illness.[3,10] It is important to note, however, that ARFID has been reported to fall into short- and long-term symptom patterns, with patients with

short-term ARFID expressing more acute symptom onset, shorter time spent in recovery paradigms, and lower frequency of long-standing histories related to gastrointestinal distress or food-related anxiety relative to patients with long-term ARFID.[6] Patients with ARFID tend to be underweight yet not as severely as patients with anorexia nervosa,[6,7,11,12] but similar levels of nutritional deficiency are exhibited in both disorders.[3,4] However, much of what is known about ARFID is derived from clinical FED populations, and therefore the presentation and prevalence of ARFID in young community-based samples are unclear.[13]

Identification of ARFID on a population-based level is complicated due to lack of standardized, comprehensive tools required to fully assess ARFID. Existing tools used to classify FED symptomatology, such as the Eating Disorders in Youth Questionnaire (EDY-Q)[14] and Eating Disorder Assessment for DSM-5 (EDA-5),[15] have not been validated to evaluate constructs specific to ARFID.[16] Other measurements more specific to ARFID such as parent-report tools or the Nine Item ARFID Screen (NIAS) are brief[17,18] and may not provide an accurate representation of ARFID in pediatric communities. Elaborate measurements of ARFID that were recently developed consist of the Pica, ARFID, and Rumination Disorder Interview (PARDI),[19] the Stanford Feeding Questionnaire-ARFID (SFQ-ARFID) Scale,[13] and the PARDI ARFID Questionnaire (PARDI-AR-Q).[16] Due to the varying level of detail in these assessments, a wide range of ARFID prevalence estimates have been described across the literature. For example, population-based surveys report ARFID prevalence rates as low as 0.3% to 2% in adults[12,20] and as high as 18%[21,22] in children and adolescents. Alternatively, interview- and questionnaire-based evaluations also using population-based samples report rates of 18%[7] and 13%.[23] These figures overlap with estimates from clinical populations, where ARFID prevalence ranges from 5% to 64%.[3,4,7,24–28] Yet, values cannot be generalized to the general pediatric population, where symptoms may be subclinical or less severe, but still heighten risk of nutritional inadequacy and suboptimal growth in children if behaviors become entrenched.

ARFID classification is further complicated by overlapping comorbidities. Diagnoses are often accompanied by other emotional or behavioral disorders such as obsessive-compulsive disorder (OCD),[3,4] autism spectrum disorder (ASD),[3] and anxiety/mood disorders.[3–5,20,24,26,29] As current ARFID research has primarily been conducted in clinical cohorts, the extent to which ARFID is associated with the spectrum of emotional or behavioral problems within the general population is unclear. Characterizing ARFID-related behaviors could assist practitioners and parents in identifying ARFID symptoms early and can inform the creation or adaptation of current treatments or clinical trials.

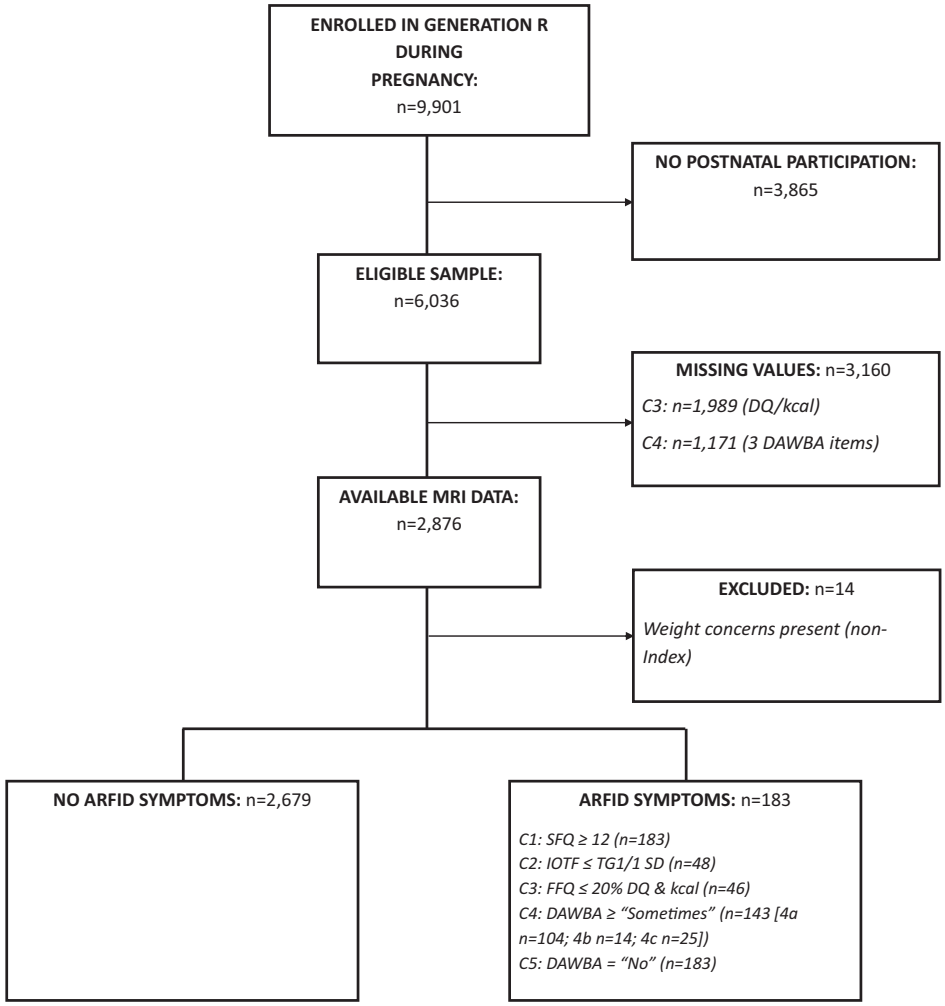
Understanding the prevalence and presentation of ARFID within the general pediatric population that meet the ARFID *DSM-5* criteria is critical to effectively inform preventive strategies and early interventions and direct public resources. This study therefore aimed to classify ARFID symptoms in a population-based study of children to systematically estimate ARFID prevalence from a range of existing measures and examine sociodemographic, appetitive, and behavioral characteristics of children with ARFID symptoms compared with children not fulfilling ARFID categorization criteria (ie, no ARFID symptoms). A secondary aim was to explore whether prevalence or associations differed by child sex. Few studies have assessed ARFID in population-based pediatric cohorts, and thus no specific hypotheses were generated relating to ARFID prevalence or associations with sociodemographic characteristics. However, we hypothesized that children with ARFID symptoms also exhibit more food avoidant traits and less food approach traits compared with children without ARFID symptomatology. We also hypothesized that children with ARFID symptoms were likely to experience more emotional and behavioral problems compared with children without ARFID symptoms.

METHOD

Study Population and ARFID Index Construction

The study sample was derived from the Generation R Study (Generation R),[30] a population-based cohort from early pregnancy onward in Rotterdam, the Netherlands. The study enrolled 9,901 pregnant women with their children born between April 2002 and January 2006. Ethics approval was obtained from the Medical Ethical Committee of Erasmus University Medical Center Rotterdam. Written informed consent was obtained from parents, with research performed in accordance with the Declaration of Helsinki. Children whose parents provided full consent up to child age 10 years were included in analysis (N = 6,036). From this sample, data on ARFID criteria were derived from different evaluative tools and questionnaires, as outlined in below and in Supplement 1 (available online). Children with missing data on either one of two key ARFID criteria (criteria 3 or 4; n = 3,160) were excluded, as these variables could not be imputed from other available indicators (Figure 1), resulting in a final sample of 2,876 children. Sociodemographic characteristics associated with picky/restrictive eating were also assessed (Supplement 1, available online). Participants lost to follow-up had lower income and

FIGURE 1 Participant Flow Diagram and Classification of Avoidant/Restrictive Food Intake Disorder (ARFID) Symptomatology Derived From the Study-Specific ARFID Index



Note: *C1-C5 = criteria 1-5; DAWBA = Development and Well-Being Assessment; DQ = dietary quality; FFQ = Food Frequency Questionnaire; IOTF = International Obesity Task Force; MRI = magnetic resonance imaging; SFQ = Stanford Feeding Questionnaire. Please note color figures are available online.*

education levels and more often originated from Africa, Asia (including Turkey), Latin America, or Oceania ($p < .001$) (Table S1, available online).

Five key ARFID *DSM-5* diagnostic criteria were aligned with corresponding and available Generation R measures (Table 1) to generate the ARFID Index and assess the prevalence of children exhibiting ARFID symptomatology. Children were categorized into the ARFID symptom group if they reported avoidant/restricted food intake (criterion 1 [C1]) in the absence of body shape/weight dissatisfaction (criterion 5 [C5]) combined with one (or more) of the following: failure to achieve expected weight gain/growth (criterion 2 [C2]), nutritional deficiency (criterion 3 [C3]), or interference with psychosocial functioning (criterion 4 [C4]) (thus, ARFID symptom classification: C1 + C5 + [C2 or C3 or C4]). Children not fulfilling these ARFID criteria were categorized as children with no ARFID symptoms.

C1 used the parent-reported 4-item picky eating scale from the Stanford Feeding Questionnaire (SFQ)[31] at 10 years. SFQ items were answered using a 5-point Likert scale (from 1 = never to 5 = always). A cutoff score of ≥12/20 was implemented to classify children with vs without ARFID symptoms, as previously described.[32] Internal consistency of the picky eating scale was high (α [95% CI] = .83 [.82, .85]).

C2 used classifications from the International Obesity Task Force (IOTF),[33] which indexed multiple international cohorts to classify child weight status based on age-/sex-specific body mass index (BMI) cutoff points. Height and

TABLE 1 Avoidant/Restrictive Food Intake Disorder (ARFID) Index Characteristics and Cutoff Scores, Including Child Age and Reporter Information From Evaluation Tools

Index criterion		Child age, y	Reporter	Evaluation tool	Classification for meeting criteria
1. Avoidant/restrictive food intake		10	Mother	SFQ: 4-item picky eating scale	≥12/20 (corresponds to ≥ "Sometimes" for all items)
2. Failure to achieve expected weight gain/growth		10	Researcher—measured	BMI categorized following IOTF classifications	≤ TG 1 (≤ −1 SD)
3. Nutritional deficiency		8	Mother	FFQ: DQ score and energy intake (kcal/d)	≤20th percentile for DQ and energy intake
4. Interference with psychosocial functioning		10	Mother	3 DAWBA items: "How often does your child's eating behavior disrupt (4a) family meals; (4b) learning or working at school; and (4c) playing, hobbies, sports, or other leisure activities?" (5-point scale)	≥ "Sometimes" on at least 1 item (≥3/15)
5. Absence of body shape/weight dissatisfaction		10	Mother	1 DAWBA item: "Is your child worried about gaining weight or becoming fat?" (3-point scale)	"No" vs "yes"/"a little bit" (≤1/3)
Appetitive/behavioral characteristics					
Appetitive	CEBQ	10	Parent/mother	**5 CEBQ subscales:** 1. Enjoyment of food (4-item) 2. Satiety responsiveness/slowness in Eating (9-item) 3. Food responsiveness (5-item) 4. Emotional undereating (4-item) 5. Emotional overeating (4-item)	N/A[a]
Behavioral	CBCL	10	Parent/mother	**5 CBCL subscales:** 1. Anxious/depressed (13-item) 2. Withdrawn/depressed (8-item) 3. Attention problems (10-item) 4. Somatic complaints (11-item) 5. Social problems (11-item)	N/A[a]

(*continued*)

TABLE 1 Continued

Index criterion	Child age, y	Reporter	Evaluation tool	Classification for meeting criteria
			1 *DSM-5* oriented CBCL subscale:	
			1. Attention-deficit/hyperactivity problems (7-item) (3-point scale)	
SRS	6	Parent/mother	Full SRS (18-item short version) (4-point scale)	N/A[a]
SOCS	10	Parent/mother	Full SOCS (7-item) (3-point scale)	N/A[a]

Note: *A child classifies as presenting with ARFID symptoms if they meet criteria 1 and 5 and at least 1 of the subcriteria (2-4). BMI = body mass index; CBCL = Child Behavior Checklist; CEBQ = Child Eating Behaviour Questionnaire; DAWBA = Development and Well-Being Assessment; DQ = Diet Quality; FFQ = Food Frequency Questionnaire; IOTF = International Obesity Task Force; N/A = not applicable; SD = Standard Deviation; SFQ = Stanford Feeding Questionnaire; SOCS = Short OCD Screener; SRS = Social Responsiveness Scale; TG = thinness grade.*

[a]*No cutoff parameters used for analysis of appetitive and behavioral characteristics.*

weight in Generation R were assessed by trained staff during the age 10 years research visits. Weight was measured in undergarments using a mechanical personal scale (seca, Hamburg, Germany), and height was measured via a Harpenden stadiometer (Holtain Ltd., Crymych, United Kingdom). C2 cutoff scores consisted of participants who fell between IOTF thinness grades 1 to 3 (reflecting ≤ -1 SD BMI).

C3 was assessed via dietary quality (DQ) score and energy intake (kcal/day) obtained through a parent-reported Food Frequency Questionnaire (FFQ)[34] at 8 years (most recent data collection of FFQ items). This FFQ version contains 71 items to evaluate consumption frequency, portion size, and dish preparation methods of foods commonly consumed by Dutch children in the preceding 4 weeks. From the FFQ, continuous measurements of DQ scores[35] were derived that reflect adherence to Dutch dietary guidelines for children of this age, with higher scores indicating higher adherence to optimal diet quality (Supplement 1, available online). Continuous measurements of average daily energy intake (in kcal) were also derived from the FFQ using the Netherlands Food Composition (NEVO) table. There is currently no known cutoff score to indicate risk of nutritional deficiency using DQ scores or energy intake, with many evaluations consisting of blood tests, laboratory assays, and specific micronutrient deficiencies when available.[5,11] Therefore, children in the lowest 20th percentile of the population for DQ scores and energy intake in kcal were classified as meeting C3.

C4 was assessed via parent report at 10 years of age using 3 study-specific items from the Development and Well-Being Assessment (DAWBA).[30,36] Parents responded to the question: "How often does your child's eating behavior disrupt (4a) family meals; (4b) learning or working at school; (4c) playing, hobbies, sports, or other leisure activities?" An ordinal 5-point Likert scale (from 1 = never to 5 = always) was used for responses. Children met C4 if parents reported that they at least "sometimes" met one of the 3 items.

C5 was assessed via a single parent-reported item from the DAWBA[30,36] at 10 years: "Is your child worried about gaining weight or becoming fat?" Responses were answered on a categorical 3-point Likert scale (from 1 = no to 3 = yes). Children experiencing "no" concern about body shape/weight relative to "a little bit"/"yes" were classified as meeting C5.

Appetitive and Behavioral Characteristics

Appetitive traits were assessed using the parent-reported Child Eating Behavior Questionnaire (CEBQ),[37] a 35-item well-validated tool assessing variation in children's eating

behavior. Parents reported on 5 of 7 CEBQ subscales at child age 10 years covering food approach traits such as enjoyment of food (4-item), food responsiveness (5-item), and emotional overeating (4-item) and food avoidant traits such as satiety responsiveness/slowness in eating (9-item) and emotional undereating (4-item). CEBQ items were summed for each subscale and answered via a 5-point Likert scale (ranging from 1 = never to 5 = always). Internal consistency of CEBQ subscales was considered acceptable in our cohort (enjoyment of food α [95% CI] = .86 [.85, .87], satiety responsiveness α = .84 [.83, .85] food responsiveness α = .86 [.85, .87], emotional undereating α = .86 (.85, .87), and emotional overeating α = .92 [.91, .93]).

Parents reported on children's anxiety, depression, attention problems, somatic problems, and ASD/OCD traits. All behavioral characteristics were evaluated using the Child Behavior Checklist for Ages 6-18 (CBCL/6-18)[38] when children were aged 10 years, excluding ASD/OCD traits. For this study, 5 syndrome scales were evaluated: anxious/depressed traits (13-item), withdrawn/depressed traits (8-item), attention problems (10-item), somatic complaints (11-item), and social problems (11-item). The CBCL *DSM-5* oriented subscale, attention-deficit/hyperactivity problems (7-item) was also selected for analysis. CBCL items were scored via 3-point Likert scales (ranging from 0 = not true to 2 = very true/often true). Internal consistency of items within each CBCL subscale was acceptable within our cohort (α = .64-.82).

ASD traits were assessed using the 18-item short version of the Social Responsiveness Scale (SRS),[39] a screening tool developed to evaluate ASD symptoms such as social impairment and autistic mannerisms. Parents completed the SRS at child age 6 (most recent data collection of SRS items). SRS items were answered using a 4-point Likert scale (ranging from 0 = not true to 3 = almost always true) with reported sum scores used for this study. Internal consistency of SRS items was acceptable (α [95% CI] = .77 [.72, .80]). OCD traits were assessed using the Short OCD Screener (SOCS),[40] a 7-item scale used to assess compulsive behaviors within pediatric populations. Items were scored by parents and summed for analysis at age 10 using a 3-point Likert scale (ranging from 0 = no to 2 = a lot). Internal consistency of items was acceptable (α = .76 [.74, .78]). Additional information concerning implementation of appetitive/behavioral characteristics and derivation of sociodemographic characteristics can be found in Supplement 1 (available online), with child age of measurement collection presented in Table 1. As it was requested for questionnaires to be completed by the primary caregiver, the used parent-report measures predominantly consisted of mother's reports.

Data Analysis

Analyses were performed using IBM SPSS (IBM Corp., Version 26.0, Armonk, New York) and R (R Foundation for Statistical Computing, Version 3.6.0, Vienna, Austria) software. Data on missing items on C1 (picky eating, n = 48), C2 (IOTF grade, n = 108), and C5 (body dissatisfaction, n = 4) were imputed using other available indicator variables, including parent-reported child problematic eating at age 10 (ie, 1-item, CBCL: "Does not eat well"), IOTF classifications at age 6, age-/sex-adjusted BMI SD scores at 6 and 13 years, and dietary restraint from the Dutch Eating Behavior Questionnaire (DEBQ)[41] at age 10. Imputation was conducted via the R mice package, resulting in 50 imputed datasets with missing values being replaced with corresponding pooled imputed mean values. After imputation, participants were classified via the ARFID Index (Table 1). Participants not meeting ARFID Index criteria were classified as children with no ARFID symptoms. To reduce the possibility of other FED symptoms within the no symptom group, participants exhibiting body shape/weight dissatisfaction were excluded from analyses (n = 14). Participants meeting ARFID Index criteria will be further referred to as children with ARFID symptoms.

Differences in sociodemographic characteristics, appetitive traits, and behavioral characteristics between children with vs without ARFID symptoms were examined using independent sample t tests or two-proportion z tests. $p < .05$ significance was used and corrected for false discovery rate (FDR). Sex and age were included as covariates in all analyses. General linear models and Pearson correlation coefficient (r) were used to investigate sex interactions between classification and characteristics of interest.

As the emergence of body weight/shape dissatisfaction only begins to appear at age 10 and increases with age,[42] it is possible that C5 items may require flexible application at this age range. To explore this, a sensitivity analysis was performed including children who fell under C5 item "no" (n = 183) or "a little bit" (n = 79) as presenting with ARFID symptoms, as opposed to our previous analysis including only "no" items.

RESULTS

From our sample (N = 2,862), 6.4% (n = 183) of children presented with ARFID symptoms (Table 2) based on ARFID Index classification parameters (Table 1). These children presented with lower BMI SD scores at age 10 ($d = -0.63$, $p_{FDR} < .001$), higher picky eating ($d = 1.87$, $p_{FDR} < .001$), and psychosocial impact (Family Meals: $d = 1.68$, $p_{FDR} < .001$; Learning/Working: $d = 0.38$,

TABLE 2 Sociodemographic and Parental Characteristics in Children With and Without Avoidant/Restrictive Food Intake Disorder (ARFID) Symptoms

Characteristics	Total (N = 2,862)		ARFID S. (n = 183)		No ARFID S. (n = 2,679)				
	n	(%)	n	(%)	n	(%)	t/p[a]	p (FDR)	d
Sex, male	2,862	(49.2)	183	(54.6)	2,679	(49.1)	$p = .146$	1.75×10^{-1}	0.11
National origin									
Dutch	2,136	(74.6)	131	(71.6)	2,005	(74.8)	$p = 3.73 \times 10^{-1}$	3.94×10^{-1}	−0.11
Other Western	256	(8.9)	14	(7.7)	242	(9.0)	$p = 6.60 \times 10^{-1}$	6.17×10^{-1}	
Non-Western	467	(16.3)	38	(20.8)	429	(16.0)	$p = 1.14 \times 10^{-1}$	1.47×10^{-1}	
	Mean	**(SD)**	**Mean**	**(SD)**	**Mean**	**(SD)**			
Birth weight, g	3,449.6	(568.1)	3,373.2	(598.4)	3,454.8	(565.8)	t = −2.0	9.22×10^{-2}	−0.14
BMI, weight/height^2, 9 y	0.12	(1.0)	−0.44	(1.2)	0.16	(0.9)	t = −8.1	2.40×10^{-15}***	−0.63
Mean picky eating sum score, SFQ scale: 0-20	9.2	(3.5)	14.7	(2.1)	8.8	(3.2)	t = 23.8	$<9.00 \times 10^{-16}$***	1.87
Mean DQ score, FFQ scale: 0-10	4.6	(1.2)	3.7	(1.2)	4.7	(1.2)	t = −9.9	$<9.00 \times 10^{-16}$***	−0.79
Mean energy intake, kcal	1,490.0	(353.9)	1,367.6	(350.4)	1,498.1	(352.7)	t = −5.0	1.82×10^{-6}***	−0.37
Mean psychosocial impact, DAWBA scale: 0-15									
Family meals	1.4	(0.7)	2.4	(1.1)	1.3	(0.6)	t = 21.3	$<9.00 \times 10^{-16}$***	1.68
Learning/work	1.1	(0.5)	1.3	(0.7)	1.1	(0.4)	t = 4.6	1.03×10^{-5}***	0.38
Playing/hobbies	1.2	(0.6)	1.4	(0.8)	1.2	(0.6)	t = 4.3	3.67×10^{-5}***	0.39
Mean body shape/weight dissatisfaction, DAWBA scale: 0-2	1.3	(0.5)	1.0	(0.0)	1.3	(0.5)	t = 8.7	$<9.00 \times 10^{-16}$***	−0.69
Parental Characteristics	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**			
Maternal education									
University education	1,962	(68.6)	115	(62.8)	1,847	(68.9)	$p = 3.81 \times 10^{-2}$	7.65×10^{-2}	0.16
No university education	817	(28.6)	65	(35.5)	752	(28.1)			
Household income									
≤2,400 EUR	478	(16.7)	40	(21.9)	438	(16.4)	$p = 6.72 \times 10^{-2}$	1.10×10^{-1}	0.15
>2,400 EUR	2,200	(76.9)	131	(71.6)	2,069	(77.2)			
	Mean	**(SD)**	**Mean**	**(SD)**	**Mean**	**(SD)**			
BMI mother, weight/height^2	24.1	(3.8)	23.9	(3.5)	24.1	(3.8)	t = −1.3	2.34×10^{-1}	−0.08

Note: *Incomplete percentages are due to missing values in data. BMI = body mass index (corrected for age and sex); DAWBA = Development and Well-Being Assessment; EUR = euro; FDR = false discovery rate; FFQ = Food Frequency Questionnaire; S. = symptoms; SD = standard deviation; SFQ = Stanford Feeding Questionnaire.*

[a]*t values reported for Student t tests, p values reported for two-proportion z tests.*

***p < .001.

$p_{FDR} < .001$; Playing/Hobbies: $d = 0.39$, $p_{FDR} < .001$) as well as lower diet quality ($d = -0.79$, $p_{FDR} < .001$), lower mean energy intake ($d = -0.37$, $p_{FDR} < .001$), and body weight/shape dissatisfaction ($d = -0.69$, $p_{FDR} < .001$) (Table 2). Despite a higher proportion of boys among participants with vs without ARFID symptomatology (54.6% vs 49.1% male), ARFID symptom classification did not differ by child sex ($p_{FDR} = .175$), BMI ($p_{FDR} = .234$), birth weight ($p_{FDR} = .092$), ethnic background (Dutch: $p_{FDR} = .394$; other Western: $p_{FDR} = .617$; non-Western: $p_{FDR} = .114$), household income ($p_{FDR} = .0761$), and maternal education level ($p_{FDR} = .141$). From this sample, 10.2% (n = 293) of children presented with subthreshold ARFID symptoms (C1 + C5) but did not meet the criteria for ARFID symptom classification. Only 1.2% (n = 33) of children presented with all ARFID Index criteria (C1 + C5 + [C2 + C3 + C4 (a, b, or c)]) (Table S2, available online); in addition, these children had the lowest mean values for birth weight, diet quality scores, and energy intake across samples.

TABLE 3 Differences in Eating Behavior in Children With and Without Avoidant/Restrictive Food Intake Disorder (ARFID) Symptoms

	ARFID S. (n = 183)		No ARFID S. (n = 2,679)				
Eating behavior	**Mean**	**(SD)**	**Mean**	**(SD)**	**t (ARFID S.– no ARFID S.)**	***p* (FDR)**	***d***
Enjoyment of food, SR 4-20	11.9	(2.6)	14.6	(2.5)	−13.4	$< 5.00 \times 10^{-16}$***	−1.06
Satiety responsiveness/SiE, SR 9-45	28.6	(6.0)	22.6 (5.7)		13.7	$< 5.00 \times 10^{-16}$***	1.06
Food responsiveness, SR 5-25	8.7	(3.7)	9.2	(3.7)	−1.6	1.49×10^{-1}	−0.14
Emotional undereating, SR 4-20	9.8	(3.9)	9.1	(3.6)	2.9	6.12×10^{-3}**	0.21
Emotional overeating, SR 4-20	5.8	(2.9)	6.0	(2.6)	−0.5	5.99×10^{-1}	−0.08

Note: *Lost to follow-up: n = 44 (enjoyment of food, satiety responsiveness), n = 46 (food responsiveness), n = 86 (emotional undereating), n = 96 (emotional overeating). FDR = false discovery rate; S. = symptoms; SiE = slowness in eating; SR = score range.*
***p < .01; ***p < .001.*

Compared with children without ARFID symptoms, children presenting with ARFID symptomatology had a decreased Enjoyment of Food score ($d = -1.06$, $p_{FDR} < .001$) and increased Satiety Responsiveness/Slowness in Eating ($d = 1.06$; $p_{FDR} < .001$) and Emotional Undereating (ie, eating less in response to stress/negative emotions) ($d = 0.21$; $p_{FDR} < .01$) scores (Table 3). No differences were found between children with vs without ARFID symptoms for Food Responsiveness (ie, urge to eat in the presence of food cues) ($p_{FDR} = .149$) and Emotional Overeating (or eating to suppress/soothe negative emotions) ($p_{FDR} = .599$) subscales. Children exhibiting ARFID symptomatology had significantly elevated scores on all CBCL subscales used compared with children with no ARFID symptomatology (Table 4) with effect sizes ranging from $d = 0.30$ to $d = 0.38$ (anxious/depressed: $d = 0.30$, $p_{FDR} < .001$; withdrawn/depressed: $d = 0.38$, $p_{FDR} < .001$; attention problems: $d = 0.38$, $p_{FDR} < .001$; *DSM*-oriented attention/hyperactivity problems: $d = 0.34$, $p_{FDR} < .001$; somatic complaints: $d = 0.32$, $p_{FDR} < .001$; social problems: $d = 0.34$, $p_{FDR} < .001$). Children with ARFID symptoms also presented with increased mean traits of ASD and OCD via respective SRS ($d = 0.22$, $p_{FDR} < .05$) and SOCS ($d = 0.15$, $p_{FDR} < .05$) scores, but to a lesser extent. No sex interactions were identified across all appetitive and behavioral characteristics.

In sensitivity analyses applying less strict parameters for C5 (body shape/weight dissatisfaction), 9.2% (n = 262) of children were identified as presenting with ARFID symptoms. Findings show that children with ARFID symptomatology were more likely to be from an ethnic background outside of the Netherlands ($p_{FDR} < .001$)/less likely to be Dutch ($p_{FDR} < .05$), more likely to live in low-income households ($p_{FDR} < .01$), and slightly more likely to have mothers with lower levels of education ($p = .0489$; $p_{FDR} = .0677$) (Table S3, available online), which differed from original analysis findings, in which no differences between ethnicity, familial income, or maternal education were identified. Findings regarding appetitive (Table S4, available online) and emotional characteristics (Table S5, available online) remained very similar, although differences between children with vs without ARFID symptoms were slightly smaller, apart from the SOCS score (*d* increased from 0.15 to 0.26). As with original analyses, no sex interactions were found across classifications, appetitive characteristics, or behavioral characteristics.

DISCUSSION

The current study developed an ARFID Index aligning with *DSM-5* diagnostic criteria to characterize and better understand ARFID in a population-based sample of children. According to this classification, 6.4% of children in a sample of 2,862 youth reported ARFID symptoms and expressed additional food avoidant traits beyond selective and restrictive eating, such as increased emotional undereating and satiety responsiveness and decreased enjoyment of food. Additionally, children with ARFID symptoms exhibited increased emotional and behavioral problems, including anxiety, withdrawn/depressed, attention/somatic/social problems, and ASD/OCD traits, relative to children without ARFID symptoms. Contrasting previous findings displaying higher proportionality of males with ARFID,[3,5–9] there were no significant differences in male-to-female ratios among populations with vs without ARFID symptoms. Similarly, no sex differences across both eating and behavioral characteristics were found, and it may be possible that sex-related differences are diluted in community-based vs

TABLE 4 Differences in Emotional and Behavioral Problems in Children With and Without Avoidant/Restrictive Food Intake Disorder (ARFID) Symptoms

	ARFID S. (n = 183)		No ARFID S. (n = 2,679)		t (ARFID S. – no ARFID S.)			
Emotional behavior	**Mean**	**(SD)**	**Mean**	**(SD)**	**Mean**	**(SD)**	***p* (FDR)**	***d***
Anxious/depressed, SR 0-26	2.9	(3.2)	2.1	(2.6)	3	9	1.27×10^{-4}***	0.30
Withdrawn/depressed, SR 0-16	1.7	(1.8)	1.1	(1.6)	4	9	7.43×10^{-6}***	0.38
Attention problems, SR 0-20	4.1	(3.5)	3.0	(3.0)	4	6	1.39×10^{-5}***	0.38
DSM-oriented attention/ hyperactivity problems, SR 0-14	3.3	(3.3)	2.4	(2.6)	4	1	5.92×10^{-5}***	0.34
Somatic complaints, SR 0-14	1.8	(2.0)	1.3	(1.7)	4	2	5.06×10^{-5}***	0.32
Social problems, SR 0-22	2.3	(2.8)	1.5	(2.0)	4	6	1.39×10^{-5}***	0.34
SRS, SR 0-54	4.5	(4.1)	3.7	(4.0)	2	6	1.20×10^{-2}*	0.22
SOCS, SR 0-16	2.4	(2.5)	2.0	(2.3)	2	4	1.68×10^{-2}*	0.15

Note: *Lost to follow-up: n = 75 (anxious/depressed, withdrawn/depressed, attention problems, attention-deficit/hyperactivity problems, somatic complaints, social problems), n = 79 (somatic problems), n = 176 (SRS), and n = 7 (SOCS). FDR = false discovery rate; S. = symptoms; SOCS = Short OCD Screener; SR = score range; SRS = Social Responsiveness Scale.*
*p < .05; ***p < .001.

clinical samples. The 10.2% of children presenting with subthreshold ARFID symptoms as well the 1.2% expressing all ARFID Index criteria also exhibited differences in picky eating and reductions in DQ. Findings from these different classifications defining ARFID provide support for the ARFID Index, with the children falling under stricter criteria indeed presenting with increased severity of ARFID symptomatology, while the children presenting with subthreshold symptomatology exhibited decreased severity. Similar, yet slightly smaller effect sizes were seen for appetitive and emotional characteristics within our sensitivity analyses using a less strict criterion for body weight/shape dissatisfaction. These children still presented with ARFID symptomatology, suggesting that concern regarding weight and shape is possible in the classification or diagnosis of ARFID. Future research assessing body weight concerns in patients with ARFID may benefit from distinguishing between healthy and pathological or disordered concerns to specify how these behaviors manifest in ARFID and may differ compared to other FEDs.

Associations between ARFID and described eating behaviors suggests that our ARFID Index was valid and contributes toward establishing characteristics associated with this FED. Other tools used to classify ARFID consist of the PARDI/PARDI-AR-Q,[16,19] SFQ-ARFID Scale,[13] and NIAS,[17] which identifies predominant presentations of avoidant/restrictive eating characterizing ARFID development. The PARDI is a clinical tool available for all ages, but due to administration length, it may not be practical for clinical use,[16] while the corresponding nonclinical, self-report PARDI-AR-Q has been reported as an accurate self-report measure for possible ARFID but has not yet focused on assessment of the younger pediatric population (<14 years). The SFQ-ARFID is a brief yet robustly constructed 12-item scale derived from the SFQ, but it does not provide information concerning nutritional intake/DQ within scale items,[13] and it has yet to be used within observational/population-based paradigms. The NIAS is validated for self- or parent-reported behaviors for individuals ranging in age from 10 to 76 years, but it does not consider factors such as DQ, growth, or psychosocial impairment,[17] but rather considers symptoms of general appetite, picky eating, and fear. These quite specific assessments were used in a study by Dinkler *et al.*,[18] in which a recent parent-reported screener using screening measurements including the PARDI, EDE-Q, and NIAS reported a prevalence of 1.3% in a Japanese sample of 4- to 7-year-olds. A study using a simpler 5-item parent-report identified a prevalence of 15.7% in a sample of 330 children 5 to 10 years old. Similar to the current study, the authors aligned items with the *DSM-5* ARFID diagnostic criteria, but did not include a multitool screening measurement to evaluate ARFID or incorporate weight/shape concern into classifications.[21] We found a distinct difference in prevalence (6.4% vs 9.2%) depending on the flexibility/strictness of incorporated body weight/shape concern, which may explain such contrasting reports. Alternatively, prevalence differences may vary due to multiple other factors, such as differential ARFID presentation across age, altered parental/self-views on appetite, or strictness of criteria for ARFID classification.

Regarding eating behavior characteristics, research corroborates findings of decreased food enjoyment and satiety

responsiveness, with extensive reports of patients with ARFID experiencing food avoidance,[22,24,26] food neophobia,[12,21,22,29] and lack of interest in food.[3,5,7,22,27,29] Current findings also align with research showing that patients with ARFID report increased sensitivity to satiety or fullness cues,[18,26,43] with studies also using the Satiety Responsiveness CEBQ subscale.[18,43] Increased levels of PYY, a peptide associated with satiety, has been found in patients with ARFID relative to controls[44] and may explain the mechanism behind this finding. In the current study, children with ARFID symptoms also presented with increased emotional undereating, or decreased eating in response to stress or negative emotions. The association between ARFID and emotional undereating has been reported previously[18] and is important considering that children with ARFID symptoms also experience more emotional and behavioral problems, suggesting an interaction between eating behavior and emotional problems. Furthermore, a previous twin heritability study showed that emotional undereating is a learned rather than inherited behavior,[45] and thus emotional undereating may be a learned response to stress. Thus, ARFID may occur or develop partially due to maladaptive learned responses to emotional problems. Future research is required to investigate this relationship and unravel how the expression of emotional undereating and ARFID symptoms are prospectively associated and whether emotional undereating could be a trigger or maintaining factor for ongoing food avoidance/restriction.

We found that children with vs without ARFID symptoms showed higher levels of emotional and behavioral symptoms such as traits of anxiety and withdrawn/depressed and traits of attention/ADHD-oriented, somatic, and social problems. In the literature, children with ARFID have reported with higher levels of internalizing and overall difficulties as measured with the Strengths and Difficulties Questionnaire.[13] Studies on picky eating also corroborate findings, with higher levels of anxiety, depression, and emotionality and comorbid psychopathology and lower levels of sociability associated with ARFID and picky eating in children.[3,31,46] Similarly, comorbidity between ARFID and other disorders has been well documented in previous population- and clinical-based studies, including generalized anxiety,[5,8,20,28,29] major depressive disorder/mood disorders,[8,26,28,29] bipolar disorder,[5] ADHD,[5] and posttraumatic stress disorder.[29] Our findings are consistent with reports showing increases in these various domains of disordered or psychopathological behavior. However, differences were relatively small (d = approximately 0.3-0.38), and it is unclear how commonly patients with ARFID symptoms express clinical comorbidity with other psychiatric conditions or disorders.

Children with ARFID symptoms reported increased OCD and ASD symptoms. Research reporting associations between ARFID and OCD has been sparse, with one study to date establishing a slight trend-level correlation between OCD symptoms and an ARFID diagnosis.[25] Overlapping symptomatology between both disorders may be driven by expression of similar underlying vulnerabilities to rigidity or averseness to change. Concerning ASD symptoms, our findings corroborate previous reports of high comorbidity between both conditions,[3,5,43,47] but effect sizes were relatively small. Notably, ARFID and ASD have recently been associated with similar nutritional deficiencies[47] and genetic risk mechanisms.[48]

This work has some limitations to consider. First, the study design was limited due to the availability of data within the Generation R cohort, with current measurements such as the PARDI/PARDI-AR-Q,[16,19] SFQ-ARFID,[13] or NIAS[17] not being available. While our ARFID Index reflected the *DSM-5* criteria as closely as possible, no measures were available to assess additional ARFID characteristics (ie, tube feeding, eating disturbance not better explained by lack of available food, cultural practice, or other mental health disorder). Additionally, current analyses do not consider existing clinically depicted ARFID profiles[49] (limited intake, limited variety, and aversive) in the 2022 text revision of *DSM-5* (*DSM-5-TR*) or differing disorder states presented by illness duration.[3,6,24,50] These profiles and profiles with short- or long-term ARFID may have distinct appetitive or behavioral characteristics and therefore differences in etiology. Further large-scale ARFID research would benefit from incorporating existing clinical profiles or differential evaluation of short- and long-term patients within classification protocols. Future work could also benefit from assessing more objective methods of nutritional deficiency, such as nutrient biomarkers. Regardless, dietitians support use of dietary-recall methods to evaluate particular nutritional deficiencies and provide overviews of overall population-based DQ.[5] Our use of multiple evaluation tools meant that certain questionnaires were administered at differing time points (6 and 8 vs 10 years), and the obtained data do not represent a set age or provide opportunity for longitudinal investigation. This especially extends to our reported effect sizes concerning traits of ASD via the SRS, in which a 4-year gap between measurement record and ARFID Index classification is likely to have contributed to an underestimate of the strength of this relationship. Lastly, Generation R follow-up rates reflect trends of participants with higher affluence and education continuing throughout the study. Due to selective response, assessed cohorts of children in this study may not be representative of the total population.

To our knowledge, this work consists of the largest population-based classification study of ARFID with an array of data collected on health and development of growing children. ARFID symptomatology was common in children from Generation R, estimated to affect 6.4% of this pediatric cohort. Findings regarding elevated food avoidant behaviors and emotional problems support previous reports that ARFID is associated with psychiatric comorbidity. The ARFID Index may serve as an effective screening tool for ARFID symptomatology or ARFID categorization within community samples and has potential to assess changes in symptomatology if used in longitudinal study paradigms. Due to the novelty of the ARFID diagnosis relative to other FED diagnoses, this tool may further inform efforts geared toward the treatment and prevention specific to ARFID.

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The data that support the findings of this study are available upon reasonable request to the data management team and management team of the Generation R Study (datamanagementgenr@erasmusmc.nl).

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