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Prevalence of early childhood obesity in Ireland: Differences over time, between sexes and across child growth criteria

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Summary

Background: Various child growth criteria exist for monitoring overweight and obesity prevalence in young children.

Objectives: To estimate early overweight and obesity prevalence in Ireland and compare the differences in prevalence across ages, growth criteria and sexes.

Methods: Longitudinal body mass index data from the nationally representative Growing Up in Ireland infant cohort ($n = 11\,134$) were categorized ('under-/normal weight', 'risk of overweight', 'overweight', 'obesity') using the sex- and age-specific International Obesity Task Force growth reference, World Health Organization growth standard and World Health Organization growth reference criteria. Differences in prevalences between criteria and sexes, and changes in each weight category and criterion across ages (9 months, 3 years, 5 years), were investigated.

Results: Across criteria, 11%–40% of children had overweight or obesity at 9 months, 14%–46% at 3 years and 8%–32% at 5 years of age. Prevalence estimates were highest using the World Health Organization growth reference, followed by International Obesity Task Force estimates. Within each criterion, prevalence decreased significantly over time ($p < 0.05$). However, when combining both World Health Organization criteria, as recommended for population studies, prevalence increased, due to differences in definitions between them. Significantly more boys than girls had overweight/obesity using either World Health Organization criterion, which was reversed using the International Obesity Task Force growth reference.

Conclusions: To increase transparency and comparability, studies of childhood obesity need to consider differences in prevalence estimates across growth criteria. Effective prevention, intervention and policy-making are needed to control Ireland's high overweight and obesity prevalence.

KEYWORDS
body mass index, child growth criteria, childhood obesity, Growing Up in Ireland, prevalence, sex differences

1 | INTRODUCTION

Obesity is affecting the health of children and adults across countries worldwide, and prevalence has increased over past decades.[1,2] Furthermore, in young children from birth to the age of 5 years, overweight and obesity (OWOB) was found to have increased globally, from 4.2% in 1990 to 6.7% in 2010, and more young children were at risk of overweight.[1] A more recent study estimates increases from 4.8% in 1990 to 5.9% in 2018.[3] These prevalence estimates are based on the World Health Organization (WHO) growth standard (WHO-S) definition of OWOB.[1,3] Estimates were higher in a different study using the International Obesity Task Force (IOTF) growth reference (IOTF-R) definition,[3,4] based on which one in six young children had OWOB in 2015.[4] Additionally, heterogeneity can be seen across countries and regions.[3] While young children appear understudied and data often out of date,[1,3,5] the rising prevalence seen in older children supports the notion that early OWOB is highly prevalent also.[6]

In Ireland, studies show that the mean body mass index (BMI) of children has been increasing since 1948[7,8] with inconsistent trends reported since the millennium.[9–12] In 1990, 10% of 8- to 12-year-old children were classified with overweight and 2% with obesity (IOTF-R),[8] which increased to 17%–21% for overweight and 7%–9% for obesity (IOTF-R) among 4- to 13-year-olds in 2002–2012.[9] However, various Irish studies indicate that a plateau has been reached or the prevalence of childhood OWOB in this age group possibly decreased.[9–12]

Less is known in Ireland about the OWOB prevalence from birth until 4 years, which has only been studied based on a small sample ($n = 371$) from a cross-sectional survey,[13] in the sub-sample of a regional prospective cohort study ($n = 1189$)[14] and in the infant cohort of the national Growing Up in Ireland (GUI) study ($n = 11\,134$),[15,16] all conducted between 2008 and 2013. The GUI study in particular appears useful to fill this knowledge gap as it holds a large number of standardized, longitudinal data and is representative of young children in Ireland. However, prevalence estimates from GUI, like from the other studies, are inconsistent, where one study shows an increase from 20% of OWOB prevalence in 9-months-old children to 43% in 3-year-olds using clinical WHO-S criteria,[15] and another study shows a decrease from 24% to 20% from 3 to 5 years of age, using the same data classified with IOTF-R.[16] Notably, obesity estimates in particular vary significantly, depending on the OWOB definition in use,[13–16] causing difficulties to assess and compare prevalence estimates across these studies, age groups and over time.

While the majority of international population-level studies assess child weight status using BMI,[17,18] the potential for cross-country comparisons and changes over time, sex and ages is not fully exploited, particularly in young children, where classifications of weight status and tendencies by sex can vary widely depending on which BMI-based child growth criterion is used.[5,6,17,19,20]

The most commonly applied international child growth criteria include the IOTF-R,[17,21] the WHO-S[17,22–24] and the WHO growth reference (WHO-R).[25] These three criteria were derived from large cohorts of children sampled from different reference populations in the United States (WHO-R) or across multiple countries and continents (WHO-S and IOTF-R).[17] The sex- and age-specific IOTF-R was the most widely used criterion for many years, due to its high methodological quality and a lack of robust international alternatives.[17,21] However, as more recent and partially longitudinal reference data were collected, several criteria are used now. For international comparison, the two WHO criteria are popular choices due to their high methodological rigour,[17] correlation with cardio-metabolic health risks[26,27] and the bigger age span they jointly provide data for, in comparison to the IOTF-R.[17] To increase comparability across studies, the use of IOTF alongside WHO criteria is recommended.[28]

Therefore, the aim of this study was twofold, to investigate the prevalence of early childhood obesity in Ireland, and to compare estimates and trends using several growth criteria. Accordingly, this study assessed the prevalence of OWOB at the ages of 9 months, 3 years and 5 years in the GUI infant cohort using the IOTF-R, WHO-S and WHO-R criteria. Specifically, differences in prevalence estimates across ages, growth criteria and sexes were studied longitudinally.

2 | METHODS

2.1 | Study design

Secondary analysis of the infant cohort data from the prospective GUI National Longitudinal Study of Children was conducted. A probability sample of children born between 1st December 2007 and 30th June 2008 were sampled from the Irish Child Benefit Register and studied following a fixed panel design. A systematic selection procedure, pre-stratified by a number of variables and based on a random start and constant sampling fraction was used.[29] Longitudinal data were collected from families when the children were 9 months old in 2008–2009 (wave 1, $n = 11\,134$), at 3 years in 2011 (wave 2, $n = 9793$, response rate: 88%) and again at 5 years in 2013 (wave 3, $n = 9001$, response rate: 91% [81% of the wave-1 sample]).[30] Of those, 8712 families completed the interviews in all three waves (78%). Data were weighted as the attrition was slightly higher in families with lower educational levels, lower social classes and in single caregiver families.[31] However, differences between unweighted and weighted sample characteristics for each wave were small. Details have been published elsewhere.[31,32]

In each wave, trained interviewers took standardized weight measurements using the Class III SECA 835 portable electronic weight scale (Seca),[30–32] graduated by 20 g up to 20 kg and by 50 g thereafter.[33] Interviewers measured length with the SECA 210 measuring mat (Seca) when the infants were 9 months old[30] and height with a Leicester measuring stick at the following ages.[31,32] Both were recorded to the nearest millimetre.[33] Additionally, gestational age at birth (in weeks) was recorded from the primary caregiver of the child (usually the mother) in wave 1.

The GUI Researcher Microdata File was retrieved from the Department of Children and Youth Affairs.[31,32]

2.2 | Analysis

2.2.1 | Data cleaning

Means and standard deviations (SDs) for continuous variables (i.e., weight, length/height, BMI and gestational age at birth) and frequencies and proportions for sex at each wave were reported. Missing values were investigated for patterns of non-reporting. Continuous variables were tested for outliers using boxplots, and for normality and collinearity by plotting the data using histograms, assessing means and medians, and using correlation coefficients.

For each child growth criterion, children's BMI-for-age, weight-for-age and length/height-for-age were transformed into z-scores (i.e., SD) specific to sex and gestational age at birth using the *zanthro* add-on to Stata statistical software.[34,35] Following WHO guidelines, observations were considered unrealistic and thus removed, if these were outside the sex- and age-specific range of −5SD to 5SD of WHO criteria for the respective anthropometric measurement[24,36] (Appendix 1).

Furthermore, changes in weight and changes in length/height within the same child over time were investigated. With approximately 2 years between measurements, weight and length/height were expected to increase from one wave to the next. Where decreases or only marginal increases were seen between waves 1 and 2, 2 and 3 or 1 and 3, all weight or length/height and BMI data for both concerned waves were assumed to have high potential for reporting errors and hence were removed. 'Marginal increases' were defined based on outlier analysis and skewness (Appendix 1).

2.2.2 | Use of child growth criteria

At each age, BMI was grouped into sex- and age-specific weight categories for the WHO-S, WHO-R and IOTF-R individually. The WHO-S provides reference values to classify BMI from ages zero to 60 months (categories 'under- and normal weight', 'risk of overweight', 'overweight' and 'obesity'), the WHO-R from 60 months to 19 years (categories 'under- and normal weight', 'overweight' and 'obesity') and the IOTF-R from 24 months to 18 years (categories 'under- and normal weight', 'overweight' and 'obesity').[17] Accordingly, the IOTF-R was used at the ages of 3 and 5 years, only. Severe obesity, which is sometimes studied as the highest BMI category (see Table 1), was not investigated separately from moderate obesity due to very low counts (<2%).

For population monitoring, both WHO criteria define weight status based on SD from sex- and age-specific median BMI observed in their respective reference populations; however SD interpretations differ, as shown in Table 1.

While the WHO enabled the continuity and thus the comparability of BMI percentiles (used for clinical monitoring) across both WHO criteria by smoothing the WHO-R dataset,[20,25,26] the WHO-S and WHO-R use different SD thresholds to define the BMI status. Namely, children with an age- and sex-specific BMI > 1SD above the reference median are defined as 'at risk of overweight', BMI > 2SD with 'overweight' and BMI > 3SD with 'obesity' according to the WHO-S. The same thresholds correspond to 'overweight' (>1SD), 'obesity' (>2SD) and 'severe obesity' (>3SD) in the WHO-R. For both the WHO-S and WHO-R, BMI < 1SD defines 'under- and normal weight'. In practice, this means that a child classified with overweight at the age of 59 months, based on the WHO-S, would likely be classified with obesity 1 month later when the WHO-R is applied. To track changes in BMI deviations from the median between the ages in a coherent manner, findings are presented for all ages using the WHO-S classification, and additionally at 5 years using the WHO-R classification. For comparison with other studies, interpretations of BMI thresholds are provided using both the WHO-S and WHO-R classifications across the ages.

TABLE 1 Thresholds of the World Health Organization (WHO) child growth criteria

Thresholds	WHO growth standard (0–60 months)	WHO growth reference (5–19 years)
For clinical assessment		
85th percentile (1.04 SD)	Overweight	Overweight
95th percentile (1.65 SD)	Obesity	Obesity
For epidemiological studies		
1 SD (84.1th percentile)	Risk of overweight	Overweight
2 SD (97.7th percentile)	Overweight	Obesity
3 SD (99.9th percentile)	Obesity	Severe obesity

Note: Thresholds include the original percentile and standard deviation (SD) thresholds from growth criteria definitions, with mathematical equivalents in parentheses. Information from De Onis et al., 2007, Dinsdale et al., 2011 and Wright et al., 2010.

Unlike the WHO criteria, the IOTF constructed sex-specific centile curves that pass through adult BMI thresholds for overweight (BMI = 25 kg/m^2) and obesity (BMI = 30 kg/m^2) at age 18 years.[17]

2.2.3 | Analysis of prevalence

Crude prevalence of under- and normal weight (combined), risk of overweight and OWOB in the GUI infant population were identified by investigating proportions of these weight categories among children at 9 months, 3 years and 5 years, separately. Differences in proportions were assessed between various criteria at 3 and 5 years of age, overall and for boys and girls. Also, changes in each weight category and criterion over time were investigated. While referring to 'trends' over time in this manuscript, we did not apply trend analysis. Bonferroni adjustment for multiple comparisons was used to lower the risk of type I errors. Differences in proportions, 95% confidence intervals and test statistics are reported. *p*-Values <0.05 were deemed significant.

Statistical analysis was conducted using Stata version 13.[37] The *Strengthening the Reporting of Observational Studies* guidelines were used for reporting.[38]

3 | RESULTS

3.1 | Descriptive statistics

After the exclusion of missing values, outliers and invalid values, 10 810 children (49.0% girls) had a valid BMI reported at 9 months, 9422 (49.5% girls) at 3 years and 8781 (49.4% girls) at 5 years of age. Of those, 8119 children had valid BMI measurements reported for all waves. Overall, relatively few observations were excluded from the dataset and little or no changes in mean BMI at each wave were seen before and after cleaning (see Appendix 1 for details). After data cleaning, 2% of weight and length/height records, 3% of BMI and <1% of gestational age at birth were missing, reducing the sample from 29 928 to 29 013 BMI observations. At all ages, weight, length/height and BMI were distributed normally. Measurements correlated over time ($0.41 \leq r \leq 0.85$), with the highest correlation in BMI seen between 3 and 5 years of age ($r = 0.67$). Consistent BMI ranges of between 11 and 27 kg/m^2 across the ages and sexes were seen. Mean BMI was 18.2 kg/m^2 (SD = 1.7) at 9 months, 16.8 kg/m^2 (SD = 1.6) at 3 years and 16.3 kg/m^2 (SD = 1.6) at 5 years. Compared against the WHO's sex- and age-specific SD reference scales, these BMI values correspond to a mean WHO-SD score of 0.74 (SD = 1.09) at 9 months, 0.90 (SD = 1.05) at 3 years and 0.56 (SD = 1.00) at 5 years of age. Details are provided in Appendix 2.

3.2 | Differences across child growth criteria and over time

Tables 2 and 3 present the prevalence of under- and normal weight, risk of overweight and OWOB for all age groups. At the age of 9 months, based on WHO-S, the prevalence of overweight was 9.4% and prevalence of obesity was 2%, which increased significantly to almost 11% with overweight and 2.7% with obesity at 3 years of age. From 3 to 5 years, prevalences of OWOB decreased significantly to 5.8% and 1.9%, respectively, using the WHO-S classification. However, using WHO-R, the prevalence increased significantly to 23.8% for overweight and 7.7% for obesity at 5 years of age (Table 2). The large difference is as a result of children classified 'at risk of overweight' under the WHO-S criteria, while being considered with overweight when using the WHO-R. Accordingly, if the WHO-R was to be used consistently across the ages, 40% of 9-month-olds and 46% of 3-year-olds would be estimated to have OWOB.

Using the IOTF-R, the prevalence of overweight decreased significantly from 18.3% at 3 years to 15.1% at 5 years ($p = 0.01$), whereas obesity remained at 5% across both ages (Table 2).

As different growth criteria retrieved different estimates of prevalence at the ages of 3 and 5 years, differences across criteria were compared. At 3 and 5 years, prevalences of OWOB were significantly lower using the WHO-S compared to the IOTF-R (Table 3). Furthermore, at 5 years, prevalences of OWOB were higher when the WHO-R was used, than when the WHO-S or IOTF-R was applied. The WHO-S and the WHO-R led to identical estimates of under- and normal weight prevalence, but significantly higher prevalences were found using the IOTF-R both at 3 and 5 years (Table 3).

3.3 | Sex differences

Table 4 and Figures A1–A3 in Appendix 3 show the differences in prevalences between boys and girls. Based on both the WHO-S or WHO-R, significantly more girls than boys had under- or normal weight (i.e., BMI < 1SD) when they were 3 (boys: 51.4%; girls: 57.5%) or 5 years old (boys: 65.6%; girls: 71.6%), whereas significantly more 5-year-old boys had under- or normal weight if the IOTF-R was used (boys: 81.5%; girls: 78.5%). Prevalences of OWOB were higher among boys compared to girls using both WHO criteria. Specifically, at the ages of 9 months and 3 years, the differences in overweight prevalence were significant (WHO-S). At 5 years, differences in overweight were significant using the WHO-R, only, while in obesity they were significant irrespective of the WHO criterion used. Also, prevalence of risk of overweight was higher in boys using the WHO-S classification when the children were 5 years old. Using the IOTF-R, at 3 years of age, the same sex tendency was seen only for overweight although this was not significant. At the age of 5 years, this tendency was reversed and significantly more girls had overweight (IOTF-R).

4 | DISCUSSION

4.1 | Prevalence across child growth criteria and over time

The prevalence of OWOB in young children in Ireland appears high compared to many European countries,[5,39–41] with a peak prevalence of up to 46% (WHO-R classification) observed at the age of 3 years. Obesity levels were similar to the global average in 2- to 4-year-olds in 2011–2013; however, overweight was much above the global prevalence of about 10% (IOTF-R).[4]

Large discrepancies were found between prevalence estimates of OWOB depending on which growth criterion was used. Estimates of both OWOB were highest when the WHO-R classification was applied, followed by the IOTF-R estimates and lowest using the WHO-S, which has also been observed in other studies.[19] Specifically, 9% of 9-month-old children were classified with overweight using the WHO-S, compared to 29% using the WHO-R classification. This changed to a range from 11% (WHO-S) to 32% (WHO-R) in 3-year-olds and from 6% (WHO-S) to 24% (WHO-R) in 5-year-olds. The corresponding IOTF-R estimates were somewhat in the middle, with 18% at 3 years and 15% at 5 years of age. Additionally, 2% of 9-month-old children were classified with obesity using the WHO-S and 9% using the WHO-R classification. Obesity ranged from 3% (WHO-S) to 11% (WHO-R) at 3 years and 2% (WHO-S) to 6% (WHO-R) at 5 years, with IOTF-R estimates equating to 5% at both ages. Differences in estimates of overweight and of obesity between criteria remained stable over time.

TABLE 2 Time trends in prevalence of weight categories from 9 months (n = 10 810) to 3 years (n = 9422) and 5 years of age (n = 8781) using various child growth criteria. Differences in proportions, 95% confidence intervals (CIs) and Bonferroni-adjusted p-values are presented.

Criterion	Child age	Under- and normal weight	Risk of overweight	Overweight	Obesity
WHO-S	9 months % (95% CI)	59.6% (58.7% to 60.5%)	29.0% (28.1% to 29.8%)	9.4% (8.8% to 9.9%)	2.0% (1.8% to 2.3%)
	N	*n* = 6444	*n* = 3132	*n* = 1015	*n* = 219
	3 years % (95% CI)	54.4% (53.4% to 55.4%)	32.1% (31.1% to 33.0%)	10.9% (10.2% to 11.5%)	2.7% (2.4% to 3.0%)
	N	*n* = 5124	*n* = 3021	*n* = 1024	*n* = 253
	5 years % (95% CI)	68.5% (67.6% to 69.5%)	23.8% (22.9% to 24.7%)	5.8% (5.3% to 6.2%)	1.9% (1.6% to 2.2%)
	N	*n* = 6017	*n* = 2092	*n* = 505	*n* = 167
	Difference in proportions (95% CI), adjusted p-values	*9 months vs. 3 years*	*9 months vs. 3 years*	*9 months vs. 3 years*	*9 months vs. 3 years*
		−5.2% (−6.6% to −3.8%)	*3.1% (1.8% to 4.4%)*	*1.4% (0.6% to 2.2%)*	*0.7% (0.3% to 1.1%)*
		p = 0.01	*p = 0.01*	*p = 0.02*	*p = 0.02*
		3 years vs. 5 years	*3 years vs. 5 years*	*3 years vs. 5 years*	*3 years vs. 5 years*
		14.1% (12.7% to 15.5%)	*−8.3% (−9.6% to −7.0%)*	*−5.0% (−5.8% to −4.2%)*	*−0.8% (−0.4% to −0.1%)*
		p = 0.01	*p = 0.01*	*p = 0.01*	*p = 0.01*
		9 months vs. 5 years	*9 months vs. 5 years*	*9 months vs. 5 years*	*9 months vs. 5 years*
		8.9% (7.6% to 10.2%)	*−5.2% (−6.4% to −3.9%)*	*−3.6% (−4.3% to −2.9%)*	*−0.1% (−0.2% to 0.3%)*
		p = 0.01	*p = 0.01*	*p = 0.01*	*p = 0.99*
WHO-R	5 years % (95% CI)	68.5% (67.6% to 69.5%)	N/A	23.8% (22.9% to 24.7%)	7.7% (7.1% to 8.2%)
	N	*n* = 6017		*n* = 2092	*n* = 672
WHO-S (9 months, 3 years) + WHO-R (5 years)	*Difference in proportions (95% CI), adjusted p-values*	*9 months vs. 3 years*	*9 months vs. 3 years*	*9 months vs. 3 years*	*9 months vs. 3 years*
		−5.2% (−6.6% to −3.8%)	*3.1% (1.8% to 4.4%)*	*1.4% (0.6% to 2.2%)*	*0.7% (0.3% to 1.1%)*
		p = 0.01	*p = 0.01*	*p = 0.02*	*p = 0.02*
		3 years vs. 5 years		*3 years vs. 5 years*	*3 years vs. 5 years*
		14.1% (12.7% to 15.5%)		*13.0% (11.9% to 14.1%)*	*5.0% (4.4% to 5.6%)*
		p = 0.01		*p = 0.01*	*p = 0.01*
		9 months vs. 5 years		*9 months vs. 5 years*	*9 months vs. 5 years*
		8.9% (7.6% to 10.2%)		*14.4% (13.4% to 15.4%)*	*5.7% (5.1% to 6.3%)*
		p = 0.01		*p = 0.01*	*p = 0.01*
IOTF	3 years % (95% CI)	76.5% (75.7% to 77.4%)	N/A	18.3% (17.5% to 19.1%)	5.2% (4.7% to 5.6%)
	N	*n* = 7212		*n* = 1724	*n* = 486
	5 years % (95% CI)	80.2% (79.4% to 81.0%)	N/A	15.1% (14.3% to 15.8%)	4.7% (4.3% to 5.2%)
	N	*n* = 7042		*n* = 1322	*n* = 417
	Difference in proportions (95% CI), adjusted p-values	*3 years vs. 5 years*	N/A	*3 years vs. 5 years*	*3 years vs. 5 years*
		3.7% (2.5% to 4.9%)		*−3.2% (−4.3% to −2.1%)*	*−0.4% (−10.3% to 0.2%)*
		p = 0.01		*p = 0.01*	*p = 0.99*

Note: Italics to highlight differences in proportions.
Abbreviations: IOTF-R, International Obesity Task Force growth reference; WHO-R, World Health Organization growth reference; WHO-S, World Health Organization growth standard.

TABLE 3 Comparison of prevalence estimates of weight categories across growth criteria at 9 months (n = 10 810), 3 years (n = 9422) and 5 years of age (n = 8781). Differences in proportions, 95% confidence intervals (CIs) and Bonferroni-adjusted p-values are presented.

Child age	Criterion	Under- and normal weight	Risk of overweight	Overweight	Obesity
9 months					
% (95% CI)	WHO-S	59.6% (58.7% to 60.5%)	29.0% (28.1% to 29.8%)	9.4% (8.8% to 9.9%)	2.0% (1.8% to 2.3%)
N		$n = 6444$	$n = 3132$	$n = 1015$	$n = 219$
3 years					
% (95% CI)	WHO-S	54.4% (53.4% to 55.4%)	32.1% (31.1% to 33.0%)	10.9% (10.2% to 11.5%)	2.7% (2.4% to 3.0%)
N		$n = 5124$	$n = 3021$	$n = 1024$	$n = 253$
	IOTF	76.5% (75.7% to 77.4%)	N/A	18.3% (17.5% to 19.1%)	5.2% (4.7% to 5.6%)
		$n = 7212$		$n = 1724$	$n = 486$
	Difference in proportions (95% CI), adjusted p-values	*22.1% (20.8% to 23.4%)*	N/A	*7.5% (6.5% to 8.4%)*	*2.5% (1.9% to 3.1%)*
		$p < 0.01$		$p < 0.01$	$p < 0.01$
5 years					
% (95% CI)	WHO-S	68.5% (67.6% to 69.5%)	23.8% (22.9% to 24.7%)	5.8% (5.3% to 6.2%)	1.9% (1.6% to 2.2%)
N		$n = 6017$	$n = 2092$	$n = 505$	$n = 167$
	WHO-R	68.5% (67.6% to 69.5%)	N/A	23.8% (22.9% to 24.7%)	7.7% (7.1% to 8.2%)
		$n = 6017$		$n = 2092$	$n = 672$
	IOTF	80.2% (79.4% to 81.0%)	N/A	15.1% (14.3% to 15.8%)	4.7% (4.3% to 5.2%)
		$n = 7042$		$n = 1322$	$n = 417$
	Difference in proportions (95% CI), adjusted p-values	*WHO-S vs. IOTF*	N/A	*WHO-S vs. WHO-R*	*WHO-S vs. WHO-R*
		11.7% (10.4% to 13.0%)		*18% (17.0% to 19.0%)*	*5.8% (5.2% to 6.4%)*
		$p < 0.01$		$p < 0.01$	$p < 0.01$
		WHO-S vs. WHO-R		*WHO-S vs. IOTF*	*WHO-S vs. IOTF*
		0% (−1.4% to 1.4%)		*9.3% (8.4% to 10.2%)*	*2.9% (2.4% to 3.4%)*
		$p = 0.99$		$p < 0.01$	$p < 0.01$
		IOTF vs. WHO-R		*IOTF vs. WHO-R*	*IOTF vs. WHO-R*
		11.7% (10.4% to 13.0%)		*8.7% (7.5% to 9.9%)*	*2.9% (2.2% to 3.6%)*
		$p < 0.01$		$p < 0.01$	$p < 0.01$

Note: Italics to highlight differences in proportions.
Abbreviations: IOTF-R, International Obesity Task Force growth reference; WHO-R, World Health Organization growth reference; WHO-S, World Health Organization growth standard.

TABLE 4 Sex-differences in prevalence of weight categories at 9 months (n = 10 810), 3 years (n = 9422) and 5 years of age (n = 8781) using various child growth criteria. Differences in proportions, 95% confidence intervals (CIs) and Bonferroni-adjusted p-values are presented.

Child age		Under- and normal weight	Risk of overweight	Overweight	Obesity
9 months					
% (95% CI)	Boys WHO-S	58.2% (56.9% to 59.5%)	29.1% (27.9% to 30.3%)	10.2% (9.4% to 11.0%)	2.4% (2.0% to 2.8%)
N		n = 3212	n = 1606	n = 564	n = 133
	Girls WHO-S	61.0% (59.7% to 62.4%)	28.8% (27.6% to 30.3%)	8.5% (7.8% to 9.3%)	1.6% (1.3% to 2.3%)
		n = 3232	n = 1526	n = 451	n = 86
	Difference in proportions (95% CI); adjusted p-*value*	*2.8% (1.0% to 4.6%)*	*−0.3% (−2.0% to 1.4%)*	*−1.7% (−2.8% to − 0.6%)*	*−0.8% (−1.3% to − 0.3%)*
		p = *0.06*	p = *0.99*	p = *0.04*	p = *0.06*
3 years					
% (95% CI)	Boys WHO-S	51.4% (50.0% to 52.8%)	33.3% (31.9% to 34.6%)	12.4% (11.5% to 13.4%)	2.9% (2.4% to 3.4%)
N		n = 2445	n = 1583	n = 592	n = 139
	Girls WHO-S	57.5% (56.0% to 58.9%)	30.8% (29.5% to 32.3%)	9.3% (8.4% to 10.1%)	2.4% (2.0% to 2.9%)
		n = 2679	n = 1438	n = 432	n = 114
	Difference in proportions (95% CI); adjusted p-*value*	*6.1% (4.1% to 8.1%)*	*−2.5% (−4.3% to − 0.6%)*	*−3.1% (−4.3% to − 1.8%)*	*−0.5% (−1.1% to 0.1%)*
		p = *0.02*	p = *0.18*	p = *0.02*	p = *0.99*
	Boys IOTF	76.2% (75.0% to 77.4%)	N/A	18.9% (17.8% to 20.2%)	4.9% (4.3% to 5.5%)
		n = 3628		n = 898	n = 233
	Girls IOTF	76.9% (75.6% to 78.1%)	N/A	17.7% (16.6% to 18.8%)	5.4% (4.8% to 6.1%)
		n = 3584		n = 826	n = 253
	Difference in proportions (95% CI); adjusted p-*value*	*0.7% (−1.0% to 2.4%)*	N/A	*−1.2% (−2.8% to 0.4%)*	*0.5% (−0.4% to 1.4%)*
		p = *0.99*		p = *0.99*	p = *0.99*
5 years					
% (95% CI)	Boys WHO-S	65.6% (64.1% to 66.9%)	25.7% (24.4% to 27.0%)	6.4% (5.6% to 7.1%)	2.4% (2.0% to 2.9%)
N		n = 2910	n = 1141	n = 282	n = 107
	Girls WHO-S	71.6% (70.2% to 72.9%)	21.9% (20.7% to 23.1%)	5.1% (4.5% to 5.8%)	1.4% (1.0% to 1.7%)
		n = 3107	n = 951	n = 223	n = 60
	Difference in proportions (95% CI); adjusted p-*value*	*6.1% (4.2% to 8.0%)*	*−3.8% (−5.6% to − 2.0%)*	*−1.3% (−2.3% to − 0.3%)*	*−1.0% (−1.6% to − 0.4%)*
		p = *0.02*	p = *0.02*	p = *0.14*	p = *0.02*
	Boys IOTF	81.8% (80.7% to 83.0%)		13.8% (12.7% to 14.8%)	4.4% (3.8% to 5.0%)
		n = 3634		n = 611	n = 195
	Girls IOTF	78.5% (77.3% to 79.7%)		16.4% (15.3% to 17.5%)	5.1% (4.5% to 5.8%)
		n = 3408		n = 711	n = 222
	Difference in proportions (95% CI); adjusted p-*value*	*−3.4% (−5.1% to − 1.7%)*	N/A	*2.6% (1.1% to 4.1%)*	*0.7% (−0.2% to 1.6%)*
		p = *0.02*		p = *0.02*	p = *0.99*

(Continues)

TABLE 4 (Continued)

Child age		Under- and normal weight	Risk of overweight	Overweight	Obesity
	Boys WHO-R	65.5% (64.1% to 66.9%)	N/A	25.7% (24.4% to 27.0%)	8.8% (7.9% to 9.6%)
		n = 2910		*n* = 1141	*n* = 389
	Girls WHO-R	71.6% (70.2% to 72.9%)	N/A	21.9% (20.7% to 23.1%)	6.5% (5.8% to 7.3%)
		n = 3107		*n* = 951	*n* = 283
	Difference in proportions (95% CI); adjusted p-value	*6.1% (4.2% to 8.0%)*	N/A	*−3.8% (−5.6% to − 2.0%)*	*−2.3% (−3.4% to − 1.2%)*
		p = 0.02		*p* = 0.02	*p* = 0.02

Note: Italics to highlight differences in proportions.
Abbreviations: IOTF-R, International Obesity Task Force growth reference; WHO-R, World Health Organization growth reference; WHO-S, World Health Organization growth standard.

Accounting for differences between various growth criteria, these estimates are comparable to the 26% in OWOB prevalence (IOTF-R) identified among 3-year-old children in the smaller Irish National Preschool Nutrition Survey conducted around the time of GUI.[13] However, OWOB prevalences were below those identified in an urban, regional (non-representative) sample of 2-year-old children[14] and above those modelled in Irish 2- to 4-year-old children.[4] Similar gaps between growth criteria were found in other countries, where more agreement between WHO and IOTF criteria started to be seen in mid-childhood.[19,20]

In the GUI infant cohort, trends in prevalence depended on the growth criterion used for interpretation. Specifically, between the ages of 3 and 5 years, prevalence decreased if either the WHO-S or WHO-R classification were used consistently at both ages, a trend that was also observed when BMI percentiles from the same cohort were compared.[42] However, prevalence increased dramatically if the WHO-S was used at 3 years and the WHO-R at 4 years, which are the recommended criteria at these respective ages. In line with other studies,[19,43] trends appeared more stable using the IOTF-R than either WHO criterion. Using the IOTF-R, only a decline in overweight, but not obesity, was seen.

Unfortunately, no older or newer data from young Irish children are available to indicate whether this trend constitutes a time trend in OWOB prevalence or an age-typical pattern. Contemporaneous findings from the National Preschool Nutrition Survey indicate a similar age pattern.[13] In other countries, peak OWOB prevalence occurred at an earlier or later age within the early childhood years,[5,20,44] suggesting that variability across the ages is normal but not following a clear pattern. Overall, the plasticity of children's BMI appears highest in the youngest ages suggesting that prevention and intervention strategies should target children in their early childhood and prenatally.[45,46]

Findings from older children in Ireland indicate that OWOB may in fact be decreasing, supporting the notion of a time trend seen in GUI. However these studies are in disagreement whether this decline stems from a reduction in overweight[47] or obesity.[9] Previously, an increase in early OWOB had been projected in Ireland until 2030.[4]

Despite decreases in OWOB prevalence in this study, mean BMI still corresponded to the sex- and age-specific 75th BMI percentile on WHO growth charts[48] when children were 5 years old, which is higher than what would be expected in a healthy population of 0- to 5-year-old children. Future follow-up of the GUI infant cohort population and more recent data from young children are warranted to confirm a potential decline in childhood OWOB and, if applicable, examine the causes. While sampling of a new infant cohort appears worthwhile, other research stressed the usefulness of anthropometric data from periodic clinical growth monitoring to investigate childhood OWOB.[49]

4.2 | Sex difference

Differences in OWOB prevalences were seen between boys and girls at all ages. Notably, depending on which criterion was used, sex tendencies of obesity were reversed at 3 and 5 years of age, as were overweight tendencies at 5 years. The WHO-S consistently identified more boys than girls with overweight and with obesity at all ages (not statistically significant in the obesity category among 9-month- and 3-year-olds). Sex tendencies were comparable using the WHO-R; however the IOTF-R found no sex tendency at 3 years and identified significantly more girls with overweight at 5 years.

Surveillance data from 6- to 7-year-old children in Ireland show similar sex tendencies; however the sex gap was much bigger than in the GUI infant cohort.[10] Longitudinal data from eight European countries also found higher OWOB prevalences among 2- to 7-year-old boys than girls using WHO criteria, and higher prevalences among girls using the IOTF-R.[19] Only in Greece, which was the only European country identified to have a higher early OWOB prevalence than Ireland, different sex tendencies were seen.[44] These findings highlight the importance for studies to report their choice of growth criteria alongside sex-specific prevalence, and to interpret observed tendencies in light of this.

Overall, the variation seen in OWOB estimates confirms that careful consideration and transparent reporting is required regarding the choice of growth criteria and cutoff values. Prevalence trends and tendencies can easily be misinterpreted as different clinical and surveillance cutoff values for growth criteria tend to be used interchangeably,[20,26] and terminologies to describe BMI categories are frequently confused.[19,44] To increase the transparency and comparability of studies, the European Childhood Obesity Group suggests to adopt a common terminology across existing growth criteria, such as a distinction between 'grade 1 overweight' and 'grade 2 overweight' or 'obesity'.[50]

Generally, the WHO-R classification (defining OWOB as BMI > 1SD) appears most useful to study population-level data of young children, considering the emerging evidence on its clinical relevance[26,27] and to enable continuity from birth into adolescence. The IOTF-R and WHO-S likely underestimate the real scope of OWOB prevalence.[51] However, it is difficult to determine exact clinical relevance without measuring body fat (e.g., using dual-energy x-ray absorptiometry) or early markers for associated diseases.[52] A comparison of the sensitivity and specificity of existing growth criteria to predict these outcomes could improve the effectiveness of BMI as an inexpensive and simple tool to assess adiposity levels in young children.

4.2.1 | Implications for policy

This study showed that prevention efforts are required before children start attending school, whereas most healthy weight promotion is delivered in the school setting targeting older children.[3,53] Accordingly, Irish health services increasingly seek to raise awareness and manage early OWOB as part of routine primary care, such as through increased health professional training, integration with community services[54] and growth monitoring during vaccination appointments.[55]

Furthermore, antenatal services and maternal wards are effective contact points for interventions initiated during pregnancy that stretch into childhood.[56] However, across Ireland, a split in public and private health service provision has led to varying degrees of availability and quality of health care.[57] Policies therefore must ensure that interventions do not contribute to growing health inequalities.

To encourage Ireland in the pursuit of inclusive weight-related policies, more efforts may be required to routinely collect and analyse weight-related data (e.g., through healthcare providers), translate health research into policies and integrate obesity prevention across sectors. This may be reached through (economic) evaluations of interventions,[58] for example using microsimulation models.[59,60] The recent cost-of-illness study on childhood obesity in Ireland can help guide evaluations.[60]

4.3 | Strengths

The longitudinal GUI data offered a unique opportunity to study early OWOB prevalences in Ireland from 2008 to 2013, major strengths being the cohort's representative nature, age range and sample size. With 11 000 infants sampled through the Irish Child Benefit Register, the initial sample equated to almost one seventh of all births in Ireland in 2007[33] and was representative of the population of 3-year-olds captured in the 2011 Census of Population.[31] Reliability was increased by means of the random sampling technique. Attrition in the cohort was low (19%) and little information was missing (3%).

Self-reported weight and length/height data typically involve a high risk of measurement errors and social desirability bias, but are often used in studies as their collection is easy, inexpensive and fast.[6,61] However, as measurements in this study were standardized, no such limitations apply.

Various international child growth criteria for population-level monitoring were used to analyse OWOB prevalence, trends and sex differences, enabling the comparison with findings from other countries, across ages and over time.

4.4 | Limitations

A few limitations to this study exist. Despite its usefulness to investigate weight status, including in infants,[62] BMI does not provide as accurate estimates of individual body composition or fat mass as more sophisticated tools.[63] Furthermore, for any growth criterion, at best limited evidence exists that links BMI cutoff values to cardiometabolic risk factors or health outcomes. Nevertheless, other means to assess the weight status of young children are either subject to the same limitations[18,51] or not applicable to population-level data.[64]

We acknowledge a significant amount of time elapsed between data collection and publication, partly due to a delay in accessing the data, cleaning and checking the data, and this study was part of a larger project that constituted a broader investigation of this dataset.

Lastly, response bias was seen between waves that were addressed by over-sampling population groups expected to refuse participation, and through weighting factors.

5 | CONCLUSION

As up to 46% of 3-year-olds in the nationally representative GUI infant cohort had overweight or obesity, effective prevention, intervention and policy-making are needed before children reach school age, in order to lower the prevalence of childhood OWOB and its consequences for population health in Ireland over time. The OWOB prevalence decreased over the study period; however, it is unclear whether this constitutes an age-typical pattern or an actual decrease in population prevalence over time. Future studies should investigate the possibility of declining prevalence of OWOB. The cumulative evidence of this and other studies from Ireland indicates that there is a possibility to halt, and possibly reverse, the increasing trend of childhood OWOB in the youngest children if targeted appropriately. Lastly, in this study, in relation to observed prevalence estimates, trends and sex differences varied, depending on the child growth criterion in use. Careful reporting and investigation of accuracy of these criteria is needed.

AUTHOR CONTRIBUTIONS

SJ, FB, MW and RB contributed to the conceptualisation and study design, data interpretation, writing of the manuscript and manuscript revisions. SJ and FB conducted the data analysis and generated tables and figures. SJ conducted the literature search. Data collection was conducted by the GUI Study team.

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CONFLICT OF INTEREST

All authors declare no conflict of interests in relation to this study.

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REFERENCES

1. de Onis M, Blossner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. *Am J Clin Nutr*. 2010;92:1257-1264.
2. The Lancet Diabetes and Endocrinology. Childhood obesity: a growing pandemic. *Lancet Diabetes Endocrinol*. 2022;10:1.
3. Di Cesare M, Sorić M, Bovet P, et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. *BMC Med*. 2019;17:212.
4. Global Burden of Disease Study 2015 (GBD 2015) Obesity and Overweight Prevalence 1980-2015 [database on the Internet]. Institute for Health Metrics and Evaluation. 2017; http://ghdx.healthdata.org/record/global-burden-disease-study-2015-gbd-2015-obesity-and-overweight-prevalence-1980-2015
5. Jones R, Jewell J, Saksena R, Ramos Salas X, Breda J. Overweight and obesity in children under 5 years: surveillance opportunities and challenges for the WHO European region. *Front Public Health*. 2017;5:1-12.
6. NCD Risk Factor Collaboration. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet*. 2017;390:2627-2642.
7. Perry IJ, Whelton H, Harrington J, Cousins B. The heights and weights of Irish children from the post-war era to the Celtic tiger. *J Epidemiol Community Health*. 2009;63:262-264.
8. O'Neill JL, McCarthy SN, Burke SJ, et al. Prevalence of overweight and obesity in Irish school children, using four different definitions. *Eur J Clin Nutr*. 2007;61:743-751.
9. Keane E, Kearney PM, Perry IJ, Kelleher CC, Harrington JM. Trends and prevalence of overweight and obesity in primary school aged children in the Republic of Ireland from 2002-2012: a systematic review. *BMC Public Health*. 2014;14:974.
10. Bel-Serrat S, Heinen MM, Murrin CM, et al. *The Childhood Obesity Surveillance Initiative (COSI) in the Republic of Ireland: Findings from 2008, 2010, 2012 and 2015*. Health Service Executive; 2017.
11. O'Donnell A, Buffini M, Kehoe L, et al. The prevalence of overweight and obesity in Irish children between 1990 and 2019. *Public Health Nutr*. 2020;23:2512-2520.
12. Garrido-Miguel M, Cavero-Redondo I, Álvarez-Bueno C, et al. Prevalence and trends of overweight and obesity in European children from 1999 to 2016: a systematic review and meta-analysis. *JAMA Pediatr*. 2019;173:e192430.
13. Irish Universities Nutrition Alliance. National Pre-School Nutrition Survey - Summary Report 2012; 2018 Jun 14.
14. McCarthy EK, Chaoimh C, Murray DM, Hourihane JO, Kenny LC, Kiely M. Eating behaviour and weight status at 2 years of age: data from the Cork BASELINE Birth Cohort Study. *Eur J Clin Nutr*. 2015;69:1356-1359.
15. Jabakhanji SB, Pavlova M, Groot W, Boland F, Biesma R. Social class variation, the effect of the economic recession and childhood obesity at 3 years of age in Ireland. *Eur J Public Health*. 2017;27:234-239.
16. Growing Up in Ireland NLSCI. Key findings: infant cohort (at 5 years); 2013.
17. Dinsdale H, Ridler C, Ells L. A simple guide to classifying body mass index in children Oxford: National Obesity Observatory; 2011.
18. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Simple tests for the diagnosis of childhood obesity: a systematic review and meta-analysis. *Obes Rev*. 2016;17:1301-1315.
19. Ahrens W, Pigeot I, Pohlabeln H, et al. Prevalence of overweight and obesity in European children below the age of 10. *Int J Obes (Lond)*. 2014;38(Suppl 2):S99-S107.
20. Maalouf-Manasseh Z, Metallinos-Katsaras E, Dewey KG. Obesity in preschool children is more prevalent and identified at a younger age when WHO growth charts are used compared with CDC charts. *J Nutr*. 2011;141:1154-1158.
21. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000;320:1240-1243.
22. Wright CM, Williams AF, Elliman D, et al. Using the new UK-WHO growth charts. *BMJ*. 2010;340:c1140.
23. Grummer-Strawn LM, Reinold C, Krebs NF, Centers for Disease Control & Prevention. Use of World Health Organization and CDC growth charts for children aged 0-59 months in the United States. *MMWR Recomm Rep*. 2010;59:1-15.
24. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatr Suppl*. 2006;450:76-85.

25. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ*. 2007;85:660-667.
26. Valerio G, Balsamo A, Baroni MG, et al. Childhood obesity classification systems and cardiometabolic risk factors: a comparison of the Italian, World Health Organization and International Obesity Task Force references. *Ital J Pediatr*. 2017;43:19.
27. Oliveira GJ, Barbiero SM, Cesa CC, Pellanda LC. Comparison of NCHS, CDC, and WHO curves in children with cardiovascular risk. *Rev Assoc Med Bras (1992)*. 2013;59:375-380.
28. Rolland-Cachera MF. Childhood obesity: current definitions and recommendations for their use. *Int J Pediatr Obes*. 2011;6:325-331.
29. Quail A, Williams J, McCrory C, Murray A, Thronton M. Sample design and response in wave 1 of the infant cohort (at 9 months) of Growing Up in Ireland. Dublin: The Economic and Social Research Institute, Office of the Minister for Children and Youth Affairs, University College Dublin; 2011.
30. Quail A, Williams J, McCrory C, Murray A, Thornton M. A summary guide to wave 1 of the infant cohort (at 9 months) of Growing Up in Ireland. Dublin: The Economic and Social Research Institute, Office of the Minister for Children and Youth Affairs, University of Dublin Trinity College; 2011.
31. Murray A, Quail A, McCrory C, Williams J. A summary guide to wave 2 of the infant cohort (at 3 years) of Growing Up in Ireland. Dublin: The Economic and Social Research Institute, Department of Children and Youth Affairs, University of Dublin Trinity College; 2013.
32. Murray A, Williams J, Quail A, Neary M, Thornton M. A summary guide to wave 3 of the infant cohort (at 5 years) of Growing Up in Ireland. Dublin,: The Economic and Social Research Institute, Department of Children and Youth Affairs, Trinity College Dublin; 2015.
33. Growing Up in Ireland NLSCI. Design, instrumentation and procedures for the infant cohort at wave one (9 months). Dublin: Department of Children and Youth Affairs; 2013.
34. Vidmar S, Carlin J, Hesketh K, Cole T. Standardizing anthropometric measures in children and adolescents with new functions for egen. *Stata J*. 2004;4:50-55.
35. Vidmar SI, Cole TJ, Pan H. Standardizing anthropometric measures in children and adolescents with functions for egen: update. *Stata J*. 2013;13:366-378.
36. World Health Organization. Growth reference 5–19 years; 2017. http://www.who.int/growthref/en/
37. StataCorp. Stata Statistical Software: Release 13. TX: StataCorp LP; 2013.
38. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Int J Surg*. 2014;12:1495-1499.
39. Schmidt Morgen C, Rokholm B, Sjoberg Brixval C, et al. Trends in prevalence of overweight and obesity in Danish infants, children and adolescents—are we still on a plateau? *PLoS One*. 2013;8:e69860.
40. Pigeot I, Barba G, Chadjigeorgiou C, et al. Prevalence and determinants of childhood overweight and obesity in European countries: pooled analysis of the existing surveys within the IDEFICS consortium. *Int J Obes (Lond)*. 2009;33:1103-1110.
41. Beau AB, Tauber M, Chollet C, et al. A contemporary description of French newborns' growth using the Efemeris cohort. *Arch Pediatr*. 2017;24:424-431.
42. Jabakhanji SB, Boland F, Ward M, Biesma R. Body mass index changes in early childhood. *J Pediatr*. 2018;202:106-114.
43. Wijnhoven TM, van Raaij JM, Spinelli A, et al. WHO European Childhood Obesity Surveillance Initiative: body mass index and level of overweight among 6-9-year-old children from school year 2007/2008 to school year 2009/2010. *BMC Public Health*. 2014;14:806.
44. Hassapidou M, Daskalou E, Tsofliou F, et al. Prevalence of overweight and obesity in preschool children in Thessaloniki, Greece. *Hormones (Athens)*. 2015;14:615-622.
45. Perng W, Hajj H, Belfort MB, et al. Birth size, early life weight gain, and midchildhood cardiometabolic health. *J Pediatr*. 2016;173:122-130.e121.
46. Geserick M, Vogel M, Gausche R, et al. Acceleration of BMI in early childhood and risk of sustained obesity. *N Engl J Med*. 2018;379:1303-1312.
47. WHO European Childhood Obesity Surveillance Initiative 2015. COSI Round 4; 2018.
48. World Health Organization. Child growth standards BMI-for-age; 2014. http://www.who.int/childgrowth/standards/bmi_for_age/en/
49. Gutilla MJ, Davidson AJ, Daley MF, Anderson GB, Marshall JA, Magzamen S. Data for community health assessment in rural Colorado: a comparison of electronic health records to public health surveys to describe childhood obesity. *J Public Health Manag Pract*. 2017;23(Suppl 4):S53-s62.
50. Rolland-Cachera MF, Akrout M, Peneau S. History and meaning of the body mass index. Interest of other anthropometric measurements. Childhood Obesity eBook. Brussels, Belgium: European Childhood Obesity Group ASBL; 2018.
51. Reilly JJ, Kelly J, Wilson DC. Accuracy of simple clinical and epidemiological definitions of childhood obesity: systematic review and evidence appraisal. *Obes Rev*. 2010;11:645-655.
52. Bryant M, Ashton L, Brown J, et al. Systematic review to identify and appraise outcome measures used to evaluate childhood obesity treatment interventions (CoOR): evidence of purpose, application, validity, reliability and sensitivity. *Health Technol Assess*. 2014;18:1-380.
53. Wang Y, Cai L, Wu Y, et al. What childhood obesity prevention programmes work? A systematic review and meta-analysis. *Obes Rev*. 2015;16:547-565.
54. Health Service Executive. Making Every Contact Count: A health behaviour change framework and implementation plan for health professionals in the Irish health service; 2016.
55. Department of Health. *A Healthy Weight for Ireland: Obesity Policy and Action Plan 2016–2025*. Stationary office; 2016.
56. Wen LM, Baur LA, Simpson JM, Rissel C, Wardle K, Flood VM. Effectiveness of home based early intervention on children's BMI at age 2: randomised controlled trial. *BMJ*. 2012;344:e3732.
57. Staines A, Balanda KP, Barron S, et al. Child health care in Ireland. *J Pediatr*. 2016;177S:S87-S106.
58. Hennessy M, Byrne M, Laws R, Mc Sharry J, O'Malley G, Heary C. Childhood obesity prevention: priority areas for future research and barriers and facilitators to knowledge translation, coproduced using the nominal group technique. *Transl Behav Med*. 2018;9:759-767.
59. Cradock AL, Barrett JL, Kenney EL, et al. Using cost-effectiveness analysis to prioritize policy and programmatic approaches to physical activity promotion and obesity prevention in childhood. *Prev Med*. 2016;95:S17-S27.
60. Perry IJ, Millar SR, Balanda KP, Dee A, Bergin D, Carter L, et al. What are the estimated costs of childhood overweight and obesity on the island of Ireland? Cork, Ireland: Safefood; 2017.
61. Dubois L, Girad M. Accuracy of maternal reports of pre-schoolers' weights and heights as estimates of BMI values. *Int J Epidemiol*. 2007;36:132-138.
62. Roy SM, Chesi A, Mentch F, et al. Body mass index (BMI) trajectories in infancy differ by population ancestry and may presage disparities in early childhood obesity. *J Clin Endocrinol Metab*. 2015;100:1551-1560.
63. Meleleo D, Bartolomeo N, Cassano L, et al. Evaluation of body composition with bioimpedence. A comparison between athletic and non-athletic children. *Eur J Sport Sci*. 2017;17:710-719.

64. Rotella CM, Dicembrini I. Measurement of body composition as a surrogate evaluation of energy balance in obese patients. *World J Methodol*. 2015;5:1-9.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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