The Childhood Obesity Surveillance Initiative (COSI) in the Republic of Ireland

Findings from 2018 and 2019

nnsc National Nutrition Surveillance Centre
A Hub for Data Collation, Research, Education & Communication

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Foreword

We very much welcome the publication of this report which updates the data on trends in relation to healthy weight, overweight and obesity in primary school children in Ireland. It is the fifth round of surveillance in a 10 year period carried out in Ireland as part of the WHO-Europe Childhood Obesity Surveillance Initiative.

The stabilisation of overweight and obesity prevalence which emerged in the 4th round of surveillance in 2015 appears to be continuing, with 1 in 5 children surveyed having overweight or obesity. However, the prevalence remains relatively higher in older than in younger primary school age children. Across the cohort of schools who have participated in all rounds there continues to be a significant difference in prevalence of overweight and obesity between children attending schools designated as disadvantaged and their peers in other schools.

The findings of this report indicate that we still have a significant way to go to create environments in our homes, schools and communities that support every child to grow and develop healthily from birth through to adulthood, particularly for those who experience socio-economic disadvantage. Lifestyles and health are intrinsically linked and are heavily influenced by the prevailing environment.

We would like to thank the National Nutrition Surveillance Centre, who were commissioned to carry out this research. In particular we wish to acknowledge and thank the children who participated in the body measurements and their parents for agreeing to participate. In doing so they provide us with a vital tool for monitoring the impact of our efforts to promote healthy lifestyles and prevent childhood obesity.

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Introduction

Childhood obesity has been identified as a serious public health problem in the World Health Organization (WHO) European region [1]. The Irish Childhood Obesity Surveillance Initiative (COSI) is an ongoing, systematic process of collection, analysis, interpretation and dissemination of descriptive information for monitoring obesity, and for use in programme planning and evaluation.

This surveillance system was commissioned by the Department of Health and the Health Service Executive (HSE) in 2008, to be conducted by the National Nutrition Surveillance Centre (NNSC) based at the School of Public Health, Physiotherapy, and Sport Science in University College Dublin. Subsequent surveillance rounds were conducted in 2010, 2012, 2015, and 2018, each commissioned by the HSE. In 2016, the Department of Health launched the Obesity Action Plan 2016-2025 'A Healthy Weight for Ireland' [2], as part of the Healthy Ireland initiative. The document states short-term targets for overweight and obesity to be achieved in a five-year time frame. These include a decrease of 0.5% per year in the level of excess weight in children and a reduction in the gap in obesity levels between the highest and lowest socioeconomic groups by 10%. The policy also presents the 'Ten Steps Forward' initiative, which gathers a number of priority actions to be taken in order to prevent overweight and obesity and achieve the short-term targets. The priority action areas under Step 10, 'Monitor research and review', include 'to sustain ongoing obesity surveillance through the Healthy Ireland and Childhood Obesity Surveillance Initiative (COSI) as a means of monitoring progress.' Regular surveillance of weight status among Irish children will be essential to monitor any changes occurring in terms of childhood obesity in order to inform the policy and to evaluate progress on achieving these targets.

The COSI system aims to measure trends in overweight and obesity in primary school children in order to have a correct understanding of the progress of the epidemic in Ireland, while also allowing inter-country comparisons within the WHO European region. The implementation of a simple, effective, and sustainable surveillance system has been important in providing valuable information to be able to monitor and address the obesity epidemic in children, identify groups at risk, and evaluate the impact of obesity preventative interventions.

In this context, it is important to highlight that surveillance is not equivalent to screening. Screening involves applying a test to a defined group of persons in order to identify a risk factor or a combination of risk factors of a disease at an early stage – the people who are identified as 'at risk' are then treated. In contrast, surveillance collects anonymised data in a representative sample of people to monitor trends and for policy and planning purposes.

The core objective of COSI in Ireland is to measure weight status in primary school children by describing:

- Weight, height, body mass index (BMI), and waist circumference.
- Prevalence of underweight, normal weight, overweight, and obesity.

Methods

Study Design

The WHO European COSI is a collaborative study with principal investigators from 35 countries co-operating in relation to survey content, methodology, and timing, using a common European protocol. The Irish surveillance system followed the protocol of the WHO European COSI, which was jointly developed by the WHO Regional Office for Europe and the participating Member States. Strict adherence to the original protocol was required for inclusion in the European database, and Ireland's approach was compliant with this protocol and thus accepted for inclusion.

A flowchart demonstrating the data collection process for COSI Round 5 is presented in Figure 1.

Participants

In COSI Round 5, 135 schools consented to participate in the study. Children in first, second, fourth, and sixth class were measured. These classes include children whose age groups precede puberty, and at these ages the identification of obesity is of value to predict the condition in adulthood [3]. For each participating school, one class was randomly selected from each year to participate.

Ethical considerations

Ethical approval for the study was obtained from the University College Dublin Human Research Ethics Committee.

Consent was obtained on three levels: at school, parent, and child level. An initial letter and consent form were sent to the Principals in which the objectives of the surveillance system were explained. A final number of 135 schools consented to participate in Round 5. Subsequently, all parents from the sampled classes in participating schools were given a letter explaining the surveillance system and the anthropometric measurements. Parents were fully informed about all study procedures, and signed informed consent was obtained from a parent or guardian prior to the child's enrolment to the study. On the day of the measurements, verbal assent was obtained from the child.

To ensure confidentiality for all collected and archived data, unique identification (ID) numbers were assigned to each child and each register refers only to these numbers. The research team alone has access to the full list of ID numbers and corresponding names of the children sampled, which is held separately from the examination data. The original hard copy records are stored in locked cabinets in UCD and used only for reference if required. All information and consent forms for parents/guardians were approved by the Irish National Adult Literacy Agency (NALA).

Fieldworker Training

Prior to their recruitment, all fieldworker candidates were required to undergo the police vetting process to disclose any criminal convictions. A total of 18 fieldworkers were recruited, and each attended a training session in anthropometric measurements and data collection, following a standardised protocol drawn up by the WHO. The training included a review of the background and objectives of the surveillance system, standardised use of the forms, obtaining measurements of participants described in line with the protocol, support of children with anxieties, calibration of measurement instruments, recording measurement values immediately after reading them, and writing legibly to reduce mistakes during data transfer.

Anthropometric measurements

Measurements were conducted between October 2018 and January 2019, with a 3-week break in data collection during the Christmas holidays. Trained fieldworkers attended schools to collect all measurements. Anthropometric measurements were carried out following a standardised protocol for weight, height, and waist circumference. Leicester Height Measure stadiometers were used to measure height, WB-100MA Tanita scales were used to measure weight, and waist circumference was measured using a retractable, non-stretchable plastic tape measure (SEXA 201). Body weight scales were calibrated prior to use.

To minimise any potential for harm or discomfort, all measurements were performed in a private room or behind screens to ensure confidentiality and privacy. The fieldworkers worked in pairs and were all female. Children were asked to wear normal, light, indoor clothing without shoes. Hair ornaments were removed and ponytails undone, and all children were asked to empty their pockets.

Weight was measured in kilograms to the nearest 100 grams (0.1 kg). The stadiometers were mounted at right angles between a level floor and against a straight, vertical surface (wall or pillar). Children's height was measured in centimetres, and the reading taken to the last completed millimetre (mm). Waist circumference was taken at the midpoint between the most superior aspect of the iliac crest and the 12th rib, measured in cm and recorded to the nearest mm.

Other data

Individual information on date of birth, date and time of measurement, sex, clothes worn when measured, as well as data on school year, school name, and school address, was also collected through the core data collection form. Verbal permission was obtained from the child and recorded before the measurements were taken.

An additional form was also completed by the teacher or Principal. The mandatory school return form reported on the location of the school, the number of children registered and measured (examined) per sampled class, the number of which no parental consent was obtained, the number having refused to be measured, and those absent on the day of measurements. Additionally, a number of school (environmental) characteristics were also included, such as the frequency of physical education lessons, availability of school playgrounds, the possibility of obtaining certain foods and beverages on the school premises, and current and ongoing school initiatives organised to promote a healthy lifestyle (healthy eating, physical activity).

Parents from First and Second class children were asked if they would like to fill in a family survey form as part of the study. This survey was available to complete in hard copy and returned to UCD by post, or online through a code unique to their child, received via email. The online survey was directly uploaded to a password protected electronic data entry system, OpenClinica. Through this survey, information regarding the child's diet and physical activity pattern, and family's socioeconomic characteristics and co-morbidities, was obtained.

Feedback to parents and children

Although children's height, weight and waist circumference measurements were not routinely given to parents, they were given if requested. Children were never told their measurements, or the measurements of other children.

Data entry

All collected data were recorded on prepared data sheets, which were then returned to NNSC. Data were also recorded into the electronic data entry system (OpenClinica). Data were checked for inconsistencies. The final dataset only included children with informed consent and complete information on age and sex.

Measuring childhood obesity

BMI is an easily calculated and accessible population marker for monitoring trends in obesity. It is calculated from the formula, weight in kg/height in m^2. Although it has many weaknesses as a measure of adiposity of an individual, it is a useful measure for monitoring whole population adiposity and trend data. Cut-off points of 18.5 kg/m^2, 25 kg/m^2, and 30 kg/m^2 are used to define normal weight, overweight and obesity in adults, respectively. These cut-offs are not valid for children, however. Due to regular changes in body fat content of children as they develop, and differences between boys and girls, a single categorisation cannot be used to define childhood overweight and obesity; each sex and age group needs its own categorisation. Age- and sex-specific growth reference percentile charts and corresponding z-scores have been developed for this purpose. The percentile cut-off points at age 18 years corresponding to BMI cut-off points for underweight, normal weight, overweight, and obesity are used to calculate percentiles and z-scores for children at different ages and sex. These cut-offs are known as the International Obesity Task Force (IOTF) cut-offs [4]. They are recommended for use in international comparisons of prevalence of overweight and obesity in childhood populations and were therefore used in the current study.

Disadvantaged schools

Disadvantaged schools have been identified by the Department of Education and Skills as those schools that are at a social or economic disadvantage, which prevents students from deriving appropriate benefit from education in schools. The School Support Programme under the DEIS (Delivering Equality of Opportunity in Schools) action plan for educational inclusion, run by the Department of Education and Skills, had identified 631 disadvantaged schools in 2008. In 2018, 896 schools were identified as disadvantaged, of which 700 were primary schools. The definition of these disadvantaged schools is based upon the "educational disadvantage" in the Education Act (1998) as: "...the impediments to education arising from social or economic disadvantage which prevent students from deriving appropriate benefit from education in schools". The identification of disadvantaged schools for DEIS by the Department of Education and Skills is based on the following variables: unemployed parents, Local Authority accommodation, lone parenthood, minority ethnic groups including Travellers, free book grants, and large families (i.e. ≥ 4 siblings) [5].

Data analysis

Data were anonymised at the point of data entry. Descriptive statistics were calculated for participation rates, and all demographic and anthropometric variables. Data is presented for all children, by sex, and by class. Prevalence of weight categories was calculated by class, by sex, by urban/rural location, and by DEIS category. Pearson's chi-squared test was used to compare prevalence of overweight including obesity between classes, boys and girls, children attending urban and rural schools, and children attending DEIS and other schools. Significance was set at $p < 0.05$.

Recruitment of Schools

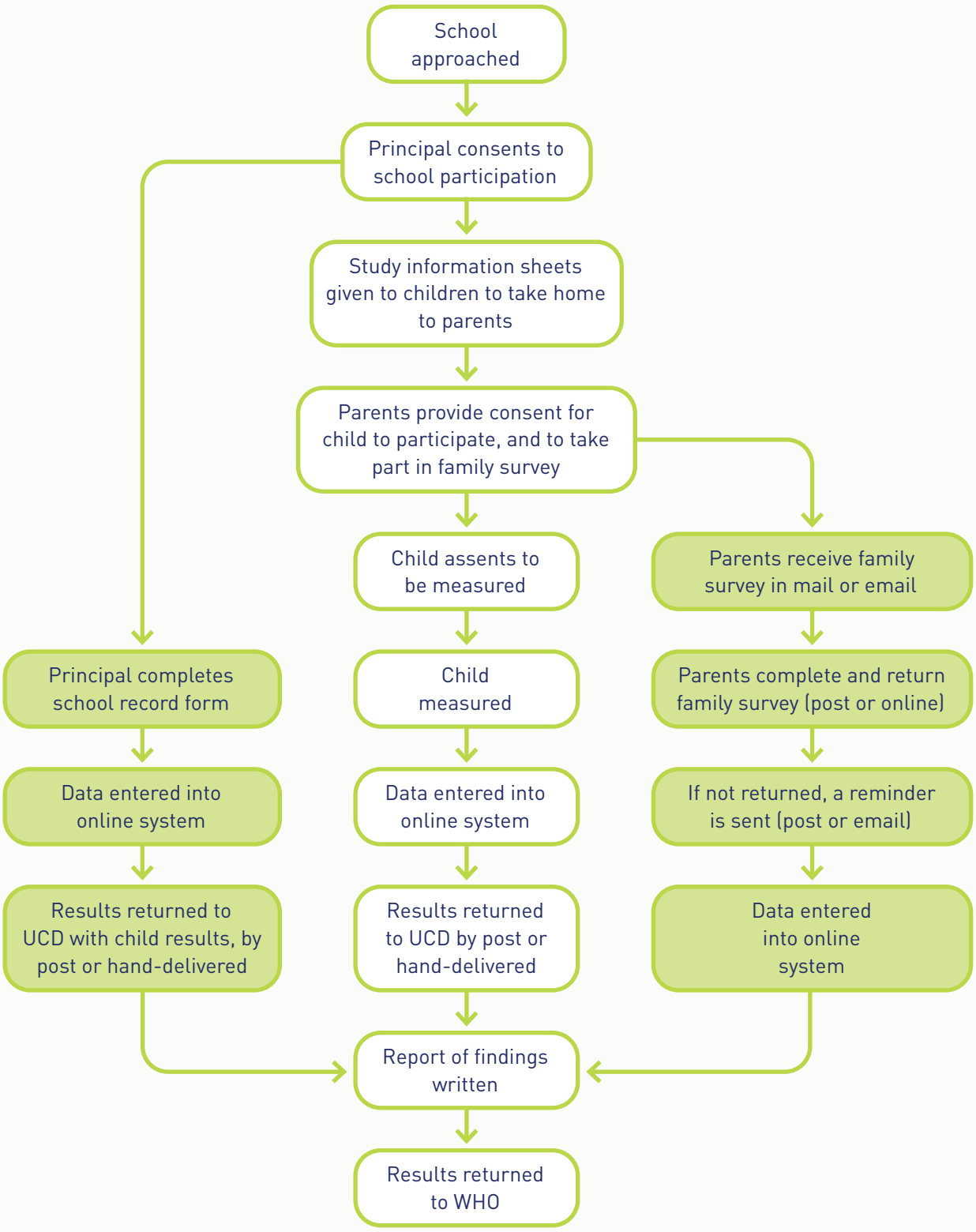
Letters were sent initially to schools inviting them to participate in the study and these were followed up by telephone calls. In 2008, 498 schools were invited, of which 163 schools consented to take part in Round 1. These randomly selected schools were a representative sample of all Irish primary schools taking into account the issue of small schools in the Republic of Ireland. Advice provided by the Department of Education and Skills assisted in the invitation of a representative sample of 75 DEIS schools, of which 23 consented to take part in Round 1.

In 2010, 2012, 2015, and 2018, only the schools that took part in 2008 were approached to participate, plus their associated senior schools (3rd to 6th class) if the junior school was included in the 2008 sample. As such, these same sentinel schools have been invited to participate in each round of COSI, and remain a representative sample of all primary schools in Ireland. In total, 185 schools were invited to participate in surveillance in round 5.

School participation rates for Round 5 were similar to that of Round 4, with a slight increase in overall number of schools participating (n = 135) reflecting the increased number of schools invited due to inclusion of associated senior schools (Table 1). 21 of the 26 invited DEIS schools were included in Round 5, which is similar to Rounds 2 and 3 participation (n = 21/25, n = 21/27, respectively), but less than Round 4 (n = 26/26). The percentage of children examined across all classes was similar, and followed a similar trend to previous rounds of COSI in Ireland. No differences were apparent between boys and girls with respect to examination rates or parent refusal rates (Table 2). For the additional family survey for first and second grade children, just under half of all invited families consented to participate, and of these only 54.3% returned the completed family survey. This results in only 1 in 4 families submitting a survey (Table 3). As such, this sample of family respondents may not accurately represent the broader population of first and second class children in Ireland.

Figure 1

Flow chart of the data collection process for Childhood Obesity Surveillance Initiative Round 5. WHO, World Health Organization



Study characteristics

Participation rates

School participation rates are presented in Table 1. In total, 135 schools consented to participate, with 50 schools declining participation. School participation rates for Round 5 were similar to Round 4 (70.5-71.6%), although lower than Rounds 2 and 3 (79.6-81.0%)

Table 1

School participation in Round 5 of Childhood Obesity Surveillance Initiative, including DEIS schools

Collection Period	Class	n	%
Oct 2018 - Jan 2019	1st class	118	
	2nd class	119	
	4th class	110	
	6th class	108	
	Total	**135/185***	**73.0%**
	Non-DEIS	114/159	71.7%
	DEIS	21/26	80.8%

**185 schools invited to participate. DEIS, Delivering Equality of Opportunity in Schools.*

Child examination rates, and response rates to the family survey, are presented in Tables 2 and 3, respectively. Examination rate of the total cohort was 57.6%, with 61.3% of parents consenting for their child to participate. The difference in consent and examination rates can be explained by the small number of children absent or declining to be measured on the day of data collection. These rates were similar across classes and between boys and girls. A small difference in examination rates was observed between disadvantaged (46.2%) and non-disadvantaged children (59.1%). The participation rate of disadvantaged children is comparable to Round 4 (43.4%, first class children only).

Table 2

Child examination rates in Round 5 of Childhood Obesity Surveillance Initiative

Class		Registered children (n)	Examined children (n (%))	Absent (n (%))	Refused (n (%))	Parents refused (n (%))
1st	Girls	1201	675 (56.2%)	34 (2.8%)	0 (0%)	492 (41.0%)
	Boys	1221	717 (58.7%)	31 (2.5%)	6 (0.5%)	467 (38.2%)
	Total	**2422**	**1392 (57.5%)**	**65 (2.7%)**	**6 (0.2%)**	**959 (39.6%)**
2nd	Girls	1307	728 (55.7%)	40 (3.1%)	0 (0%)	539 (41.2%)
	Boys	1259	758 (60.2%)	34 (2.7%)	1 (0%)	465 (36.9%)
	Total	**2566**	**1486 (57.9%)**	**74 (2.9%)**	**1 (0%)**	**1004 (39.1%)**
4th	Girls	1302	752 (57.8%)	52 (4.0%)	3 (0.2%)	495 (38.0%
	Boys	1192	708 (59.4%)	42 (3.5%)	1 (0%)	442 (37.1%)
	Total	**2494**	**1460 (58.5%)**	**94 (3.8%)**	**4 (0.2%)**	**937 (37.6%)**
6th	Girls	1236	691 (55.9%)	57 (4.6%)	0 (0%)	488 (39.5%)
	Boys	1188	672 (56.6%)	66 (5.6%)	2 (0.2%)	448 (37.7%)
	Total	**2424**	**1363 (56.2%)**	**123 (5.1%)**	**2 (0%)**	**936 (38.6%)**
Total	Girls	5046	2846 (56.4%)	183 (6.4%)	3 (0%)	2014 (39.9%)
	Boys	4860	2855 (58.7%)	173 (3.6%)	10 (0.2%)	1822 (37.5%)
	Total	**9906**	**5701 (57.6%)**	**356 (3.6%)**	**13 (0.1%)**	**3836 (38.7%)**

Response rate to the family survey was low; 46.6% of First and Second class parents consented to complete the family survey, of which only 54.3% returned the survey. This represents only 25.3% of all parents of registered First and Second class children.

Table 3

Family survey response rate in Round 5 of Childhood Obesity Surveillance Initiative

Class	Registered children (n)	Family consented (n)	Family consented (%)	Survey returned (n)	Survey returned (% of consented)	Survey returned (% of all registered)
1st Class	2422			620		25.6
2nd Class	2566			643		25.1
Total	**4988**	**2326**	**46.6**	**1263**	**54.3**	**25.3**

Results

Overweight and obesity prevalence

In total, 5701 children were examined, composed of 1392, 1486, 1460, and 1363 children from first, second, fourth, and sixth class, respectively. The results of anthropometry measurements collected on children in First, Second, Fourth, and Sixth class are presented below. Table 4 presents demographic and anthropometric characteristics of children, by class.

Table 4

Demographic and anthropometric characteristics of children by class in Round 5 of Childhood Obesity Surveillance Initiative

	Class	n	Median	P25-75
Age (years)	1st	1324	7.1	6.8-7.4
	2nd	1400	8.1	7.8-8.4
	4th	1434	10.0	9.8-10.3
	6th	1353	12.0	11.7-12.3
Age (months)	1st	1324	85.3	82.2-88.3
	2nd	1400	96.0	93.0-100.0
	4th	1434	120.5	117.4-123.9
	6th	1353	144.3	140.8-147.6
Weight (kg)	1st	1395	24.2	22.0-26.8
	2nd	1487	27.2	24.7-30.6
	4th	1460	34.1	30.2-39.6
	6th	1362	43.5	37.7-50.6
Height (cm)	1st	1395	123.7	120.0-127.6
	2nd	1487	129.5	125.4-133.3
	4th	1460	140.4	136.0-145.0
	6th	1362	152.1	147.3-157.9
WC (cm)	1st	1385	55.0	52.0-58.0
	2nd	1475	56.7	54.0-60.3
	4th	1455	60.2	56.5-66.0
	6th	1355	64.7	60.5-70.4
BMI (kg.m^{-2})	1st	1395	15.8	14.9-17.0
	2nd	1487	16.2	15.2-17.6
	4th	1460	17.3	15.9-19.4
	6th	1362	18.5	16.9-20.8

Median, the 50th percentile value; P25-75, the 25th and 75th percentile values; WC, waist circumference; BMI, body mass index.

Prevalence rates of overweight and obesity amongst each class are presented in Table 5. The trend for a plateau in prevalence of overweight and obesity in first class children identified in Round 4 of COSI appears to be continuing (Figure 2). Approximately 1 in 5 primary school children were identified as having overweight or obesity.

Differences in prevalence of overweight including obesity between boys and girls are apparent amongst all children ($p = 0.003$). Examining these differences by class demonstrates a greater prevalence of overweight including obesity in girls than boys in second class ($p = 0.003$), while no differences are seen between sexes in first, fourth, and sixth class ($p > 0.05$). A significantly lower prevalence of overweight including obesity is apparent in younger classes than older classes ($p < 0.001$).

Table 5

Weight classification using the International Obesity Task Force BMI classification, for all children by class and sex in Round 5 of Childhood Obesity Surveillance Initiative

Class	IOTF classification	Boys n (%)	Girls n (%)	Total n (%)
1st	Underweight	50 (7.0%)	51 (7.9%)	**101 (7.4%)**
	Normal	564 (79.3%)	479 (74.0%)	**1043 (76.8%)**
	Overweight	72 (10.1%)	92 (14.2%)	**164 (12.1%)**
	Obese	25 (3.5%)	25 (3.9%)	**50 (3.7%)**
	Overweight including obese	*97 (13.6%)*	*117 (18.1%)*	***214 (15.8%)***
2nd	Underweight	36 (4.9%)	48 (6.9%)	**84 (5.9%)**
	Normal	597 (81.0%)	501 (72.5%)	**1098 (76.9%)**
	Overweight	70 (9.5%)	107 (15.5%)	**177 (12.4%)**
	Obese	34 (4.6%)	35 (5.1%)	**69 (4.8%)**
	Overweight including obese	*104 (14.1%)*	*142 (20.6%)**	***246 (17.2%)***
4th	Underweight	34 (4.9%)	52 (7.0%)	**86 (5.9%)**
	Normal	514 (74.1%)	527 (70.5%)	**1041 (72.2%)**
	Overweight	111 (16.0%)	130 (17.4%)	**241 (16.7%)**
	Obese	35 (5.0%)	39 (5.2%)	**74 (5.1%)**
	Overweight including obese	*144 (21.0%)*	*169 (22.6%)*	***315 (21.8%)***
6th	Underweight	41 (6.1%)	47 (6.9%)	**88 (6.5%)**
	Normal	491 (73.3%)	486 (70.9%)	**977 (72.1%)**
	Overweight	105 (15.7%)	134 (19.6%)	**239 (17.6%)**
	Obese	33 (4.9%)	18 (2.6%)	**51 (3.8%)**
	Overweight including obese	*138 (20.6%)*	*152 (22.2%)*	***290 (21.4%)***
Total	Underweight	161 (5.7%)	198 (7.1%)	**359 (6.4%)**
	Normal	2166 (77.0%)	1993 (71.9%)	**4159 (74.5%)**
	Overweight	358 (12.9%)	463 (16.7%)	**821 (14.7%)**
	Obese	127 (4.5%)	117 (4.2%)	**244 (4.4%)**
	Overweight including obese	*485 (17.4%)*	*580 (20.9%)**	***1065 (19.1%)***

**significantly different than boys ($p < 0.05$).*

Figure 2

Prevalence of overweight including obesity in Irish school children during each round of Childhood Obesity Surveillance Initiative, categorised using International Obesity Task Force cut-offs. Values are presented for first class children for Rounds 1-5

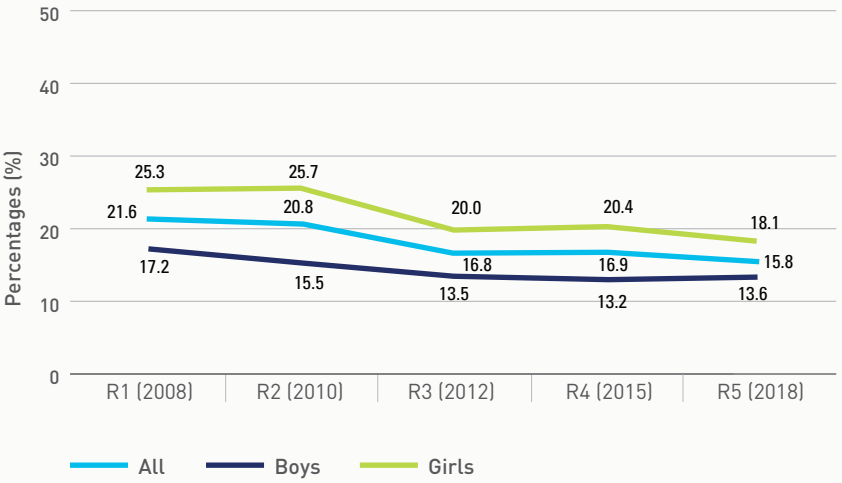


Table 6 depicts prevalence of weight categories between children attending schools classified as urban and rural. No differences were apparent between urban and rural children across the complete cohort, and by class ($p > 0.05$).

Table 6

Weight classification using the International Obesity Task Force BMI classification for all children, based on urbanisation, in round 5 of Childhood Obesity Surveillance Initiative

Class	Urbanisation	Underweight n (%)	Normal n (%)	Overweight n (%)	Obese n (%)	Overweight including obese n (%)
All	Urban	292 (6.6%)	3323 (72.6%)	643 (14.4%)	198 (4.4%)	*841 (18.8%)*
	Rural	67 (5.9%)	836 (74.2%)	178 (15.8%)	46 (4.1%)	*224 (19.9%)*
1st	Urban	77 (7.3%)	821 (77.3%)	126 (11.9%)	38 (3.6%)	*164 (15.5%)*
	Rural	24 (8.1%)	222 (75.0%)	38 (12.8%)	12 (4.1%)	*50 (16.9%)*
2nd	Urban	68 (5.9%)	893 (77.0%)	142 (11.7%)	57 (4.9%)	*199 (16.6%)*
	Rural	16 (6.0%)	205 (74.0%)	52 (13.1%)	12 (4.5%)	*64 (17.6%)*
4th	Urban	70 (6.1%)	827 (72.5%)	185 (16.2%)	59 (5.2%)	*244 (21.4%)*
	Rural	16 (5.3%)	214 (71.1%)	56 (18.6%)	15 (5.0%)	*71 (23.6%)*
6th	Urban	77 (7.0%)	782 (71.5%)	190 (17.2%)	44 (4.0%)	*234 (21.2%)*
	Rural	11 (4.2%)	195 (74.4%)	49 (18.7%)	7 (2.7%)	*56 (21.4%)*

A difference in distribution of weight categories was apparent in schools classified as disadvantaged. Table 7 demonstrates these differences, with disadvantaged schools having a higher prevalence of children with overweight or obesity across all grades ($p \leq 0.016$). The disparity between disadvantaged and other schools becomes more apparent in higher grades. Examination of overweight and obesity prevalence in disadvantaged schools with previous COSI Rounds suggests the prevalence is increasing in disadvantaged schools, and the difference between disadvantaged and other schools appears to be greater in Round 5 than in previous Rounds (Figures 3 and 4). In particular, the prevalence of overweight including obesity is much greater in disadvantaged schools than other schools in older classes.

Table 7

Weight classification using the International Obesity Task Force BMI classification for all children, based on DEIS status, in round 5 of Childhood Obesity Surveillance Initiative

Class	DEIS	Underweight n (%)	Normal n (%)	Overweight n (%)	Obese n (%)	Overweight including obese n (%)
All	Disadvantaged	19 (3.5%)	341 (63.6%)	132 (24.6%)	44 (8.2%)	*176 (32.8%)**
	Other	340 (6.7%)	3818 (75.6%)	689 (13.7%)	200 (4.0%)	*889 (17.7%)*
1st	Disadvantaged	8 (7.3%)	75 (68.2%)	18 (16.4%)	9 (8.2%)	*27 (24.6%)**
	Other	93 (7.5%)	968 (75.4%)	146 (11.7%)	41 (3.3%)	*187 (15.0%)*
2nd	Disadvantaged	4 (4.1 %)	63 (64.9%)	21 (21.6%)	9 (9.3%)	*30 (30.9%)**
	Other	80 (6.0%)	1035 (77.8%)	156 (11.7%)	60 (4.5%)	*216 (16.2%)*
4th	Disadvantaged	3 (2.0%)	95 (64.2%)	34 (23.0%)	16 (10.8%)	*50 (33.8%)**
	Other	83 (6.4%)	946 (73.1%)	207 (16.0%)	58 (4.5%)	*265 (20.5%)*
6th	Disadvantaged	4 (2.2%)	108 (59.7%)	59 (32.6%)	10 (5.5%)	*69 (38.1%)**
	Other	84 (7.2%)	869 (74.0%)	180 (15.3%)	41 (3.5%)	*221 (18.8%)*

**significantly different than other schools ($p < 0.05$). DEIS, Delivering Equality of Opportunity in Schools.*

Figure 3

Comparisons of overweight including obesity prevalence, categorised by International Obesity Task Force standards, across five rounds of Childhood Obesity Surveillance Initiative by disadvantaged schools. Values are presented for first class children for Rounds 1-5

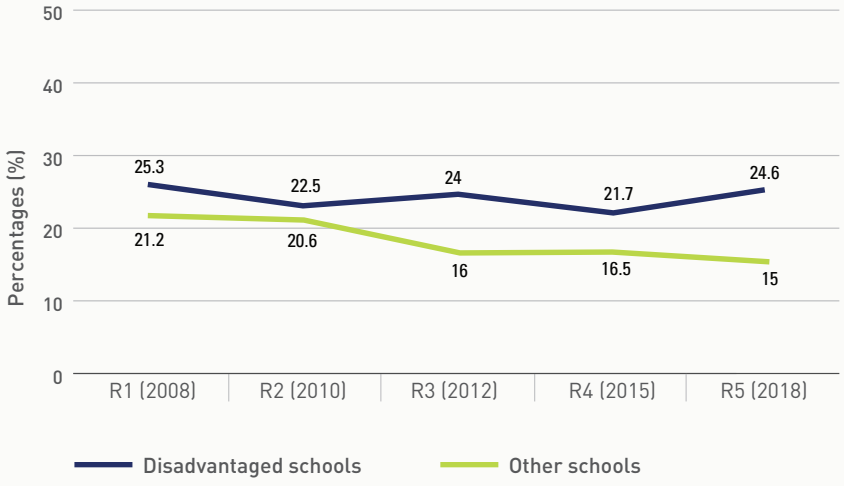
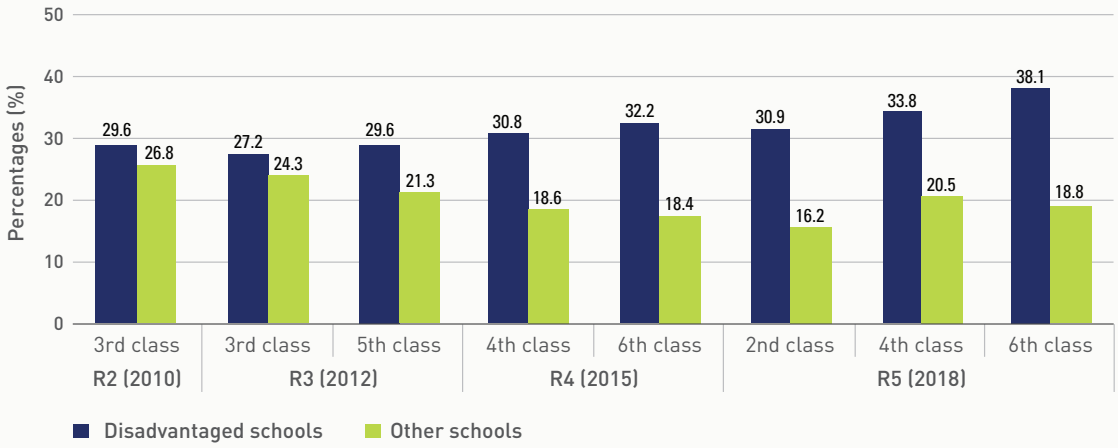


Figure 4

Comparisons of overweight and obesity, categorised by International Obesity Task Force standards, in children in second class and above across Rounds 2-5 of Childhood Obesity Surveillance Initiative by disadvantaged schools



School environment

The Principals of participating schools completed the school record form, which collected information about access to foods and fluids at school, availability of indoor and outdoor play equipment, school coordinated physical activities, and barriers to physical activity. The results are presented below for the 135 participating schools in Round 5.

Table 8

Availability of foods and beverages in schools participating in round 5 of COSI

	Free n (%)	Paid n (%)	Not available n (%)	Missing n (%)*
Water	100 (74.1%)	0 (0%)	32 (23.7%)	3 (2.2%)
Tea	3 (2.2%)	0 (0%)	120 (88.9%)	12 (8.9%)
100% fruit juice	2 (1.5%)	0 (0%)	122 (90.4%)	11 (8.1%)
Sugar sweetened fruit juice	1 (0.7%)	0 (0%)	124 (91.9%	10 (7.4%)
Carbonated beverage, sugar sweetened	1 (0.7%)	0 (0%)	125 (92.6%)	9 (6.7%)
Flavoured milk	0 (0%)	0 (0%)	126 (93.3%)	9 (6.7%)
Hot drinks, with sugar	1 (0.7%)	0 (0%)	125 (92.6%)	9 (6.7%)
Dairy	13 (9.61%)	10 (7.4%)	104 (77.0%)	8 (5.9%)
Fruit	28 (20.7%)	0 (0%)	100 (74.1%)	7 (5.2%)
Vegetables	17 (12.6%)	0 (0%)	110 (81.5%)	8 (5.9%)
Sweet snacks	1 (0.7%)	0 (0%)	124 (91.9%)	10 (7.4%)
Savoury snacks	0 (0%)	0 (0%)	124 (91.9%)	11 (8.1%)

	Yes n (%)	No n (%)	Missing n (%)*	
Are vending machines present?	0 (0%)	135 (100%)	0 (0%)	
Is the school free from advertising?	121 (89.6%)	13 (9.6%)	1 (0.7%)	
Is nutrition education included in curriculum?	131 (97.0%)	4 (3.0%)	0 (0%)	

**Missing indicates this item was not answered by the school.*

The school examination identified that sugar sweetened beverages are not available in 9 out of 10 schools, and a similar number of schools are free from advertisement or marketing of energy-dense or nutrient-poor food and drink. The majority of schools include nutrition education in their curriculum. Three-quarters of schools do not have fruits available to children, either free or for purchase. Worryingly, a minority of schools (1 in 4) do not have water available for children on their premises. All sampled schools comply with regulations regarding prohibition of vending machines in primary schools (Table 8).

Table 9

Physical activity and physical environment characteristics in schools participating in round 5 of Childhood Obesity Surveillance Initiative

	Yes n (%)	No n (%)	Missing n (%)
Does your school have outdoor play areas?	135 (100%)	0	0
Does your school have an indoor gym?	104 (77.0%)	28 (20.7%)	3 (2.2%)
Does your school curriculum include PE lessons?	135 (100%)	0	0
Minutes per week of physical education	**Mean ± SD**	**Range**	
First class	63.3 ± 15.9	30-150	
Second class	63.4 ± 16.2	40-150	
Fourth class	64.1 ± 16.9	30-150	
Sixth class	64.9 ± 19.4	30-150	

SD, standard deviation.

All schools reported including physical education lessons in their curriculum. The average weekly accumulated physical education duration was just over 60 minutes for each class. All schools had outdoor play areas for children to access during school hours, while three-quarters of schools also had an indoor gymnasium facility (Table 9).

Barriers to meeting the minimum recommendation for physical activity are presented in Table 10. Weather was identified most commonly as a barrier to meeting recommendations, with 3 in 5 schools citing this as a barrier. Facilities (45.2%) and time (37.4%) were also notable barriers.

Table 10

Barriers to meeting physical activity recommendations reported by schools in round 5 of Childhood Obesity Surveillance Initiative

	Time n (%)	Weather n (%)	Facilities n (%)	Staff training n (%)	Other n (%)
Barriers to meeting the minimum recommendation for physical activity each week	43 (37.4%)	68 (59.1%)	52 (45.2%)	9 (7.8%)	15 (13.0%)

A small percentage of schools allow children to play in outdoor play areas during extreme weather conditions, while just over 1 in 3 schools allow children to access indoor or outdoor play areas out of school hours (Table 11).

Table 11

Access to play areas during extreme weather, and out of school hours, reported by schools in round 5 of Childhood Obesity Surveillance Initiative

	Yes n (%)	No n (%)	Missing n (%)
Are children allowed to play outdoors in extreme weather conditions?	28 (20.7%)	106 (78.5%)	1 (0.7%)
Are children allowed to use outdoor play areas outside school hours?	48 (35.6%)	83 (61.5%)	4 (3.0%)
Are children allowed to use the indoor gym outside school hours?*	35 (33.7%)	66 (63.5%)	3 (2.9%)

Missing indicates this question was not answered by the school.
**, of the 104 schools which indicated they have an indoor gym (Table 9).*

Table 12

School-coordinated after-hours sports and physical activities, reported by schools in round 5 of Childhood Obesity Surveillance Initiative

	Yes, for all grades	Only to some grades	No	Missing
Does your school organise any sport/physical activities for children outside school hours?	41 (30.4%)	46 (34.1%)	46 (34.1%)	2 (1.5%)
	Yes, more than half of children	**Yes, half or less than half of children**	**No, or mostly not**	**Missing**
Do children attend these programs?	27 (31.0%)	40 (46.0%)	18 (20.7%)	2 (2.3%)

A high percentage of schools organise sports or physical activities for students outside of school hours (Table 12). However, almost 70% of these schools report half or less than half of all children participate in these programs.

Table 13

School-coordinated transport for children

	Yes, to all pupils	Only to some grade levels	Only to pupils from rural areas	Only to pupils living far away	No	Missing
Is school bus transport available to or provided by your school?	14 (10.4%)	5 (3.7%)	11 (8.2%)	26 (19.4%)	75 (56.0%)	4 (3.0%)

More than half of schools do not coordinate transport options for students, while one in five schools provide transport for students living far away (Table 13). Transport routes for students to walk or cycle to and from school were ranked on perceived safety by Principals (Table 14). The median ranking for these routes was moderately unsafe.

Table 14

How safe are the routes to and from school for most pupils to walk or ride a bicycle?

N	Median	P25-75
131	7	5-9

Rated on a scale of 1-10, with 1 indicating extremely safe, and 10 indicating extremely unsafe. Median, the 50th percentile value; P25-75, the 25th and 75th percentile values.

Family Survey

The families of first and second class children were invited to complete the family survey. This survey collected information regarding eating and activity behaviours of children, as well as sleep duration and screen time. Results of this survey are presented below. Response rate to this survey was low, with only 25.3% of all registered first and second class children represented.

Table 15

Meal behaviours of children and families reported by families in round 5 of Childhood Obesity Surveillance Initiative

	Never n (%)	Some days (1-3/week) n (%)	Most days (4-6/week) n (%)	Everyday n (%)	Other n (%)
How often does your child eat breakfast?	1 (0.1%)	22 (1.8%)	52 (4.3%)	1127 (93.8%)	15 (13.0%)
	Never n (%)	**Sometimes n (%)**	**Most days n (%)**	**At least once per day n (%)**	**More than once per day n (%)**
How often do you eat a meal together as a family?	2 (0.3%)	109 (14.1%)	256 (33.2%)	219 (21.4%)	186 (24.1%)

Most children were reported to consume breakfast daily. The contents of this breakfast is unknown, however. Almost half of the family survey respondents reported consuming a meal together as a family at least daily, with a further 33% of respondents consuming a meal together as a family on most days (Table 15).

Table 16

Frequency of consumption of different foods by children reported by families in round 5 of Childhood Obesity Surveillance Initiative

	Never n (%)	<1/week n (%)	1-3 days/week n (%)	4-6 days/week n (%)	Every day n (%)
Fruit	39 (3.3%)	31 (2.9%)	137 (11.6%)	266 (22.6%)	700 (59.5%)
Vegetables	33 (2.8%)	54 (4.6%)	204 (17.2%)	371 (31.3%)	523 (44.1%)
Soft drink	457 (38.9%)	481 (40.9%)	166 (14.1%)	44 (3.7%)	27 (2.3%)
Cereal	49 (4.2%)	63 (5.4%)	216 (18.7%)	280 (24.2%)	550 (47.5%)
Meat	18 (1.5%)	24 (2.0%)	237 (20.0%)	594 (50.0%)	314 (26.5%)
Fish	175 (14.8%)	388 (32.7%)	585 (49.3%)	31 (2.6%)	7 (0.6%)
Egg	183 (15.4%)	302 (25.5%)	581 (49.0%)	88 (7.4%)	31 (2.6%)
Low fat milk	664 (57.5%)	80 (6.9%)	79 (6.8%)	54 (4.7%)	278 (24.1%)
Whole milk	254 (21.8%)	81 (6.9%)	115 (9.9%)	122 (10.5%)	594 (50.9%)
Flavoured milk	913 (78.4%)	186 (16.0%)	44 (3.8%)	14 (1.2%)	8 (0.6%)
Cheese	183 (15.5%)	198 (16.7%)	418 (35.3%)	244 (20.6%)	141 (11.9%)
Dairy other	97 (8.1%)	138 (11.6%)	361 (30.3%)	297 (24.9%)	299 (24.9%)
Fruit juice	305 (26.4%)	333 (28.8%)	271 (23.4%)	132 (11.4%)	116 (10.0%)
Diet soft drink	835 (70.5%)	252 (21.3%)	77 (6.5%)	11 (0.9%)	9 (0.8%)
Savoury snack	48 (4.0%)	496 (41.8%)	536 (45.2%)	80 (6.7%)	27 (2.3%)
Sweet snack	17 (1.4%)	182 (15.3%)	619 (52.2%)	257 (21.7%)	111 (9.4%)
Legumes	343 (28.9%)	358 (30.1%)	408 (34.3%)	72 (6.1%)	7 (0.6%)

Frequency of consumption of different foods, as reported by family member.

The percentage of children meeting recommended dietary guidelines with respect to fruit and vegetables is poor, with only 3 in 5 children consuming fruit daily, and only 2 in 5 consuming vegetables daily. Three-quarters of children consume meat on most if not all days of the week, while half of children consume fish at least weekly. Three in 10 children were reported to consume sweet snacks on four or more days per week (Table 16).

Table 17

Method of transport to and from school for children reported by families in round 5 of Childhood Obesity Surveillance Initiative

	Walking n (%)	Cycling, skating, etc n (%)	School bus or public transport n (%)	Private motor vehicle n (%)
How does your child get to school?	282 (23.0%)	31 (2.5%)	120 (9.8%)	793 (64.7%)
How does your child get home from school?	280 (24.0%)	27 (2.3%)	121 (10.4%)	739 (63.3%)

The large majority of children travel to and from school via private transport (>60%), with a further 10% of children using public transport/school bus to travel. Approximately 1 in 4 children travel to school on foot, bicycle, scooter or other non-motorised transport (Table 17). This may reflect the degree of safety along the routes to and from school for most pupils to walk or ride (Table 14).

Table 18

Participation of children in structured physical activities outside of school reported by families in round 5 of Childhood Obesity Surveillance Initiative

	Yes n (%)	No n (%)
Is your child a member of a sports club or dance class?	1126 (91.1%)	110 (8.9%)
How many hours per week does your child spend on sports with these clubs?		
0 hours/week	109 (9.7%)	
1-3 hours/week	671 (59.8%)	
4-6 hours/week	274 (24.4%)	
7 or more hours/week	67 (6.1%)	

More than 90% of children were reported to be members of a sport club or dance class outside of school, with 60% of these children participating in activities with these clubs/classes for 1-3 hours per week (Table 18).

Table 19

Children's vigorous physical activity reported by families in round 5 of Childhood Obesity Surveillance Initiative

Outside school hours, how many hours per day does your child play actively/vigorously?	Weekday n (%)	Weekend n (%)
Never at all	6 (0.5%)	1 (0.1%)
Less than 1 hour per day	174 (14.2%)	40 (3.2%)
About 1 hour per day	520 (42.3%)	141 (11.9%)
About 2 hours per day	374 (30.5%)	392 (33.2%)
About 3 or more hours per day	154 (12.5%)	607 (51.4%)

Four in five children were reported to perform at least one hour of active/vigorous physical activity outside of school hours on weekdays. This proportion increased to over 9 in 10 children on weekends (Table 19).

Table 20

Parents' belief regarding use of mobile devices during sleep time reported by families in round 5 of Childhood Obesity Surveillance Initiative

	No, absolutely not n (%)	Yes, I do not see a problem with it n (%)	It depends on the circumstances n (%)
Should mobile devices be allowed in bedrooms during sleep time?	1097 (89.2%)	8 (0.7%)	125 (10.2%)

The majority of families agreed that mobile devices should not be allowed in children's bedrooms during sleep time (Table 20).

Table 21

Screen time including television and electronic devices, and sleep duration, of children reported by families in round 5 of Childhood Obesity Surveillance Initiative

	Median	P25-75	n
Weekday screen time (min/day)	90	60-120	1225
Weekend screen time (min/day)	180	120-240	1214
Sleep duration (hours/night)	11.0	10.5-11.25	1227

Use of television and electronic devices, and sleep duration, are presented in Table 21. Children on average spent just under 1.5 hours per weekday on an electronic device including watching television. This value increased to almost 3 hours per day on weekends. Sleep duration varied between children, with the average child sleeping for just under 11 hours per night.

Table 22

Breastfeeding history of children reported by families in round 5 of Childhood Obesity Surveillance Initiative

	No n (%)	I don't know n (%)	Yes, less than 1 month n (%)	I don't remember n (%)	Yes, for x months n (%)
Was your child ever breastfed?	455 (36.3%)	2 (0.2%)	214 (17.1%)		582 (46.4%) Median: 6.1, P25-75 = 4.0-12.0
Was your child ever exclusively breastfed?*	242 (30.6%)	0	128 (16.2%)	10 (1.3%)	410 (51.9%) Median: 5.0, P25-75 = 3.0-6.0

**only including those who indicated their child was breastfed. Median, the 50th percentile value; P25-75, the 25th and 75th percentile values.*

The breastfeeding behaviours of parents and children in this cohort reflect those of the broader Irish community [6]. Approximately half of children sampled were breastfed for at least one month. These children were breastfed for an average duration of 8.5 months. A further 17% of children were breastfed for less than 1 month. Two in 5 children were never exclusively breastfed, while 44% of children were exclusively breastfed for at least 1 month (average duration 4.9 months). Of all children who were breastfed, 3 in 10 were never exclusively breastfed (Table 22).

The representativeness of the families who responded is a limitation which must be considered when interpreting the findings of the family survey. In addition to a low response rate (25%), the sample over-represented parents/carers with third level education compared to the 2016 Ireland population census [7].

Conclusion and Implications

Participation Rates

Participation rates in Round 5 of COSI were similar to that of Round 4. Approximately 70% of schools which were invited to participate accepted the invitation. The child participation rates were also similar to Round 4, with 60% of parents consenting to have their child participate in measurements. These rates, however, are reduced compared to earlier Rounds. As such, although a representative sample of Irish school children was included in measurements, the results obtained in the current survey may not completely reflect the broader Irish children's population. It is likely that the most at-risk children may not be accounted for in the present data due to their parents declining to consent to have their child participate in measurements. This needs to be considered when interpreting the current findings. Indeed, the prevalence rates may therefore be a best-case scenario. Nevertheless, the child participation rates are similar to wider participation rates of epidemiological studies, and the slight reduction in rates also reflects trends in participation identified in epidemiological research [8].

Reasons for non-participation were not explored in this Round. However, previous research into participation attitudes in COSI showed parents express concerns about data being collected in a private setting, children's embarrassment about their results, the potential for bullying, and a possible increased likelihood of disordered eating or dieting behaviours. Despite this, parents were generally positive and accepting of having children measured in the school environment [9]. Further qualitative research examining parents' attitudes and beliefs towards obesity surveillance, as well as children's acceptance to be measured at different ages, may elucidate whether these concerns remain, while assisting in the development of strategies to target a larger percentage of children. Increasing the reach and participation of children in surveillance is essential to provide a complete description of the current state of childhood obesity in Ireland.

Although the participation rates in the current round of COSI are reduced from earlier rounds, the school recruitment procedure employed in the initial iteration of the Childhood Obesity Surveillance Initiative (2008) ensured a representative sample of Irish primary schools was included in measurements. These same sentinel schools have been invited to participate in each subsequent round of surveillance, and remain a representative sample of the Irish population of school children. This continues to be a major strength of the Childhood Obesity Surveillance Initiative.

Overweight and Obesity Prevalence

The results of the child survey demonstrate the trend for a plateau in overweight and obesity prevalence may be continuing. In total, 1 in 5 surveyed children were classified as having overweight or obesity for their age and sex. Examining prevalence rates more closely demonstrates a significantly greater rate of overweight and obesity in girls than boys across all children. Comparing boys and girls by class shows the difference is apparent in second class children, but not first, fourth and sixth class children. This is a continuation of the sex differences identified in previous Rounds, where a greater prevalence was also shown in girls than boys. In addition to sex differences, the current survey identified differences in prevalence of overweight including obesity between classes, with older classes shown to have a significantly greater prevalence rate than younger classes.

An ongoing trend in differences between disadvantaged and other schools is apparent. The prevalence of overweight and obesity was significantly greater in children attending schools classified as disadvantaged (DEIS) than other schools.

This significant difference was also established in each class. Comparisons with previous Rounds of COSI show differences have been present previously, however of concern is the apparent increase in the divergence in rates between disadvantaged and other schools. Also of note is the increasing rate of prevalence in disadvantaged schools as age increases. Prevalence of overweight and obesity was greatest in sixth class children attending disadvantaged schools, followed by fourth class children. No significant differences in prevalence rates between schools classified as urban and rural were observed in this Round.

These findings have several implications. While continuing to focus on creating conditions to achieve a healthy weight in early years, clearly there is a need to develop a better understanding of why overweight and obesity rates appear to be increasing with age, and are greater in girls than boys. In addition to a better understanding, ways this trend can be addressed are essential in meeting the long-term goals of reducing childhood overweight and obesity. Given the significant discrepancy in rates between disadvantaged and other schools, identifying and correcting factors implicated in weight gain in families experiencing socio-economic difficulties must be achieved in order to alleviate these differences.

School Environment

The school survey identified numerous positive outcomes. All schools were free from vending machines, and 9 out of 10 schools were free from advertising/marketing of energy-dense and nutrient-poor foods and beverages. Almost all schools included nutrition education in their curriculum, while 9 out of 10 schools had no sugar-sweetened beverages or sweet and savoury snacks available. All schools included physical education in their curriculum, and had an outdoor play area for children. Most children (82%) participated in physical activities as part of a sport or dance club outside of school.

In conjunction with the positive outcomes identified, the school environment could be strengthened to positively impact weight. Ensuring all schools implement the Department of Education and Skills Wellbeing Framework (2018) [10] presents an opportunity for schools to place a greater focus on health and wellbeing. In particular this will provide a focus on the environmental, cultural, and curriculum elements within the school that may impact students' weight.

Family Survey

Unfortunately, due to the very low response rate to the family survey, interpreting these findings in the broader context of the Irish population is difficult. Identifying methods to increase participation of families in future surveillance Rounds will ensure more meaningful outcomes can be delivered in this context.

The diet quality of family survey respondents varied. Breakfast was reported to be consumed daily by most children, whereas fruit and vegetable intake was low, with less than half of responders eating vegetables daily, and only 60% eating fruit daily. Most children participated in sports or dance classes outside of school, and were vigorously active for at least an hour each day.

The low response rate for the family survey may reflect both a systematic and a random bias associated with the study protocol. The systematic bias refers to parents who decline participation in the survey. Random bias refers to random non-participation, and may be associated with the data collection protocol, including the multiple stages of consent, and posting of survey forms (Figure 1).

As such, the non-participation cannot be explained solely by a lack of interest or unwillingness to provide such information by parents. Indeed, a percentage of the non-responders would be missing completely at random, and can be attributed in part to the multistage consent and measurement process required for the family survey in the current Round.

Conclusions and Policy Implications

In conclusion, the results of COSI Round 5 suggest the plateau in rates of childhood overweight including obesity appears to be continuing. However, a more nuanced examination shows that prevalence remains greater in girls than boys, older than younger children, and in children attending disadvantaged schools. As such, identifying and addressing factors implicated in these sex, age, and socio-economic differences is warranted. In addition, exploring the attitudes and beliefs of parents regarding participation in childhood anthropometry surveillance may help in the development of further strategies which can be employed to capture the wider population of Irish children. As always, a multi-level approach is required; individual, community, and national intervention is necessary to address the current state of childhood overweight and obesity.

Appendix

Anthropometric variables of all children surveyed, and prevalence rates of weight categories, presented by age in months, are presented in Tables A1 and A2, respectively.

Table A1

Anthropometric variables by age (months)

Age (months)		n	Median	P25-75
66-71	Weight (kg)	20	22.6	20.2-24.4
	Height (cm)	20	120.3	116.5-125.9
	WC (cm)	20	54.4	51.1-58.6
	BMI ($kg.m^{-2}$)	20	15.4	14.5-16.8
72-77	Weight (kg)	48	23.1	20.9-25.5
	Height (cm)	48	120.8	116.6-123.5
	WC (cm)	48	54.2	50.5-58.2
	BMI ($kg.m^{-2}$)	48	15.8	14.9-17.6
78-83	Weight (kg)	459	23.9	21.6-26.6
	Height (cm)	459	122.4	118.8-126.2
	WC (cm)	455	54.8	51.8-57.9
	BMI ($kg.m^{-2}$)	459	15.8	15.0-17.0
84-89	Weight (kg)	704	24.7	22.5-27.2
	Height (cm)	704	124.7	121.4-128.3
	WC (cm)	697	55.2	52.0-58.2
	BMI ($kg.m^{-2}$)	704	15.9	15.0-17.1
90-95	Weight (kg)	666	26.4	13.8-29.4
	Height (cm)	666	127.7	124.0-131.9
	WC (cm)	660	56.0	53.3-59.6
	BMI ($kg.m^{-2}$)	666	16.1	15.0-17.4
96-101	Weight (kg)	633	27.2	24.7-30.5
	Height (cm)	633	130.1	126.3-133.5
	WC (cm)	632	56.8	54.0-60.2
	BMI ($kg.m^{-2}$)	633	16.1	15.2-17.3
102-107	Weight (kg)	183	28.7	25.9-31.5
	Height (cm)	183	132.5	128.4-137.0
	WC (cm)	180	57.6	54.9-61.1
	BMI ($kg.m^{-2}$)	183	16.3	15.2-17.7
108-113	Weight (kg)	105	33.2	29.5-39.0
	Height (cm)	105	137.7	133.6-141.0
	WC (cm)	104	60.2	56.2-64.8
	BMI ($kg.m^{-2}$)	105	17.3	16.3-20.0

Age (months)		n	Median	P25-75
114-119	Weight (kg)	541	32.9	29.4-38.5
	Height (cm)	541	138.9	134.9-143.3
	WC (cm)	540	59.8	56.0-65.5
	BMI ($kg.m^{-2}$)	541	17.1	15.8-19.1
120-125	Weight (kg)	628	34.4	30.7-39.9
	Height (cm)	628	141.2	136.7-145.7
	WC (cm)	626	60.2	56.7-66.1
	BMI ($kg.m^{-2}$)	628	17.2	15.9-19.4
126-131	Weight (kg)	161	36.7	32.2-42.5
	Height (cm)	161	143.9	139.2-148.4
	WC (cm)	160	62.0	58.0-67.9
	BMI ($kg.m^{-2}$)	161	17.5	16.4-19.8
132-137	Weight (kg)	141	43.1	36.9-51.6
	Height (cm)	141	149.5	144.5-155.1
	WC (cm)	141	65.9	60.2-71.8
	BMI ($kg.m^{-2}$)	141	18.8	17.1-21.8
138-143	Weight (kg)	506	41.7	36.5-48.7
	Height (cm)	506	149.9	145.8-155.9
	WC (cm)	505	64.0	60.0-70.0
	BMI ($kg.m^{-2}$)	506	18.2	16.7-20.8
144-149	Weight (kg)	564	44.2	38.4-51.1
	Height (cm)	564	153.5	148.6-158.9
	WC (cm)	560	64.7	60.8-70.0
	BMI ($kg.m^{-2}$)	564	18.5	16.9-20.6
150-155	Weight (kg)	131	47.2	41.5-54.6
	Height (cm)	131	156.5	151.2-161.4
	WC (cm)	130	66.0	62.3-73.0
	BMI ($kg.m^{-2}$)	131	18.8	17.5-21.6
156-161	Weight (kg)	10	49.2	42.4-51.5
	Height (cm)	10	159.2	147.0-161.3
	WC (cm)	10	67.1	63.1-69.2
	BMI ($kg.m^{-2}$)	10	19.4	18.0-20.3
162-167	Weight (kg)	3	67.8	55.8-
	Height (cm)	3	162.5	162.3-
	WC (cm)	2	73.2	63.4-
	BMI ($kg.m^{-2}$)	3	25.6	21.1-

WC, waist circumference; BMI, body mass index.

Table A2

International Obesity Task Force (IOTF) BMI classification, for all children by age (months)

Age (months)	Underweight	Normal	Overweight	Obese	Overweight including obese
66-71	0	17 (85.0%)	2 (10.0%)	1 (5.0%)	*3 (15.0%)*
72-77	3 (6.3%)	33 (68.8%)	7 (14.6%)	5 (10.4%)	*12 (25.0%)*
78-83	27 (5.9%)	349 (76.0%)	68 (14.8%)	15 (3.3%)	*83 (18.1%)*
84-89	56 (8.0%)	529 (75.1%)	88 (12.5%)	31 (4.4%)	*119 (16.9%)*
90-95	41 (6.2%)	508 (76.3%)	82 (12.3%)	35 (5.3%)	*117 (17.6%)*
96-101	38 (6.0%)	502 (79.3%)	69 (10.9%)	24 (3.8%)	*93 (14.7%)*
102-107	16 (8.7%)	142 (77.6%)	21 (11.5%)	4 (2.2%)	*25 (13.7%)*
108-113	3 (2.9%)	74 (70.5%)	15 (14.3%)	13 (12.4%)	*18 (26.7%)*
114-119	30 (5.5%)	396 (73.2%)	90 (16.6%)	25 (4.6%)	*115 (21.2%)*
120-125	45 (7.2%)	454 (72.3%)	105 (16.7%)	24 (3.8%)	*129 (20.5%)*
126-131	7 (4.3%)	117 (72.7%)	28 (17.4%)	9 (5.6%)	*37 (23.0%)*
132-137	7 (5.0%)	87 (61.7%)	40 (28.4%)	7 (5.0%)	*47 (33.4%)*
138-143	31 (6.1%)	362 (71.5%)	90 (17.8%)	23 (4.5%)	*113 (22.3%)*
144-149	45 (8.0%)	424 (75.2%)	80 (14.2%)	15 (2.7%)	*95 (16.9%)*
150-155	6 (4.6%)	94 (71.8%)	26 (19.8%)	5 (3.8%)	*31 (23.6%)*
156-161	1 (10.0%)	8 (80.0%)	1 (10.0%)	0	*1 (10.0%)*
162-167	0	1 (33.3%)	2 (66.7%)	0	*2 (66.7%)*

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