

# Methodology and implementation of the WHO European Childhood Obesity Surveillance Initiative (COSI)

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## SUPPLEMENT ARTICLE

# Methodology and implementation of the WHO European Childhood Obesity Surveillance Initiative (COSI)

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**Abbreviations:** BMI, body mass index; COSI, Childhood Obesity Surveillance Initiative; IOTF, International Obesity Task Force; NCDs, noncommunicable diseases; PSU, primary sampling unit; SSU, secondary sampling unit; WHO, World Health Organization.

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#### Summary

Establishment of the WHO European Childhood Obesity Surveillance Initiative (COSI) has resulted in a surveillance system which provides regular, reliable, timely, and accurate data on children's weight status—through standardized measurement of bodyweight and height—in the WHO European Region. Additional data on dietary intake, physical activity, sedentary behavior, family background, and school environments are collected in several countries. In total, 45 countries in the European Region have participated in COSI. The first five data collection rounds, between 2007 and 2021, yielded measured anthropometric data on over 1.3 million children. In COSI, data are collected according to a common protocol, using standardized instruments and procedures. The systematic collection and analysis of these data enables inter-country comparisons and reveals differences in the prevalence of childhood thinness, overweight, normal weight, and obesity between and within populations. Furthermore, it facilitates investigation of the relationship between overweight, obesity, and potential risk or protective factors and improves the understanding of the development of overweight and obesity in European primary-school children in order to support appropriate and effective policy responses.

#### KEYWORDS

children, methodology, obesity, surveillance

## 1 | INTRODUCTION

Childhood obesity remains an important public health issue within the WHO European Region and around the world.<sup>1</sup> Availability of reliable and valid data on the prevalence of overweight and obesity is essential in order to be able to design effective policies and strategies to prevent and control childhood obesity. To meet the need for such reliable and valid data, and following the recommendations of the WHO European Ministerial Conference on Counteracting Obesity held in Istanbul in 2006,<sup>2</sup> the WHO Regional Office for Europe and 13 Member States established the WHO European Childhood Obesity Surveillance Initiative (COSI) in 2007.<sup>3</sup>

The aim of the initiative is to collect information on weight status, by routine and standardized measurement of bodyweight and height, and related lifestyle behaviors within nationally representative samples of primary-school children, aged between 6 and 9 years, living in the WHO European Region.

Since COSI's launch in 2007, the number of countries participating has increased from 13 to 45 (Table 1), although a few countries did not collect data in 2020/2021 due to the COVID-19 pandemic. It is now the largest childhood obesity surveillance initiative in the world. This paper describes the COSI methodology used to generate

reliable and valid data, enabling comparisons between countries and thereby contributing to the understanding of the development of childhood overweight and obesity in Europe.

## 2 | METHODS

Data are collected according to a common protocol devised by the WHO Regional Office for Europe and Member States.<sup>4</sup> The original protocol, drawn up in 2007,<sup>5</sup> has been slightly modified for subsequent rounds of data collection.<sup>4,6–8</sup> The aim of the protocol is to standardize conditions around data collection as much as possible, while still allowing participating countries some flexibility to adapt the system to their national context. This flexibility has enabled some countries—such as Belgium, Czechia, Denmark, Finland, France, Israel, Netherlands, North Macedonia, Slovenia, and Sweden—to integrate COSI into existing surveillance systems.<sup>9</sup>

### 2.1 | Study design and sampling

Participating countries can select one or more of the following four age groups: 6.0–6.9, 7.0–7.9, 8.0–8.9 or 9.0–9.9 years of

**TABLE 1** Expansion of the WHO European Childhood Obesity Surveillance Initiative (COSI)

ROUND 1 (2007–2008)	ROUND 2 (2009–2010)	ROUND 3 (2012–2013)	ROUND 4 (2015–2017)	ROUND 5 (2018–2020)
1. Belgium	1. Belgium	1. Belgium	1. Albania	1. Albania
2. Bulgaria	2. Bulgaria	2. Bulgaria	2. Belgium	2. Austria
3. Cyprus	3. Cyprus	3. Cyprus	3. Bulgaria	3. Belgium
4. Czechia	4. Czechia	4. Czechia	4. Cyprus	4. Bulgaria
5. Ireland	5. Ireland	5. Greece	5. Czechia	5. Croatia
6. Italy	6. Italy	6. Hungary	6. Greece	6. Cyprus
7. Latvia	7. Latvia	7. Ireland	7. Hungary	8. Czechia
8. Lithuania	8. Lithuania	8. Italy	8. Ireland	9. Denmark
9. Malta	9. Malta	9. Latvia	9. Italy	10. Estonia
10. Norway	10. Norway	10. Lithuania	10. Latvia	11. Finland
11. Portugal	11. Portugal	11. Malta	11. Lithuania	12. France
12. Slovenia	12. Slovenia	12. North Macedonia	12. Malta	13. Georgia
13. Sweden	13. Sweden	13. Norway	13. North Macedonia	14. Greece
	14. Greece	14. Portugal	14. Norway	15. Hungary
	15. Hungary	15. Slovenia	15. Portugal	16. Ireland
	16. North Macedonia	16. Spain	16. Republic of Moldova	17. Italy
	17. Spain	17. Sweden	17. Romania	18. Kazakhstan
		18. Albania	18. San Marino	19. Kyrgyzstan
		19. Republic of Moldova	19. Slovenia	20. Latvia
		20. Romania	20. Spain	21. Lithuania
		21. San Marino	21. Sweden	22. Malta
		22. Turkey	22. Turkey	23. Montenegro
			23. Austria	24. North Macedonia
			24. Croatia	25. Norway
			25. Denmark	26. Poland
			26. Estonia	27. Portugal
			27. Finland	28. Republic of Moldova
			28. France	29. Romania
			29. Georgia	30. Russian Federation <sup>a</sup>
			30. Kazakhstan	31. San Marino
			31. Kyrgyzstan	31. Serbia
			32. Montenegro	32. Slovakia
			33. Poland	33. Slovenia
			34. Russian Federation <sup>a</sup>	34. Spain
			35. Serbia	35. Sweden
			36. Slovakia	36. Tajikistan
			37. Tajikistan	37. Turkey
			38. Turkmenistan	38. Turkmenistan <sup>c</sup>
				39. Azerbaijan <sup>c</sup>
				40. Armenia
				41. Bosnia and Herzegovina <sup>cd</sup>
				42. Germany <sup>b</sup>
				43. Israel
				44. Netherlands <sup>c</sup>
				45. Uzbekistan <sup>c</sup>

Note: Countries written in red participated in COSI for the first time. Countries written not in bold did not collect data in the related COSI round.

<sup>a</sup>Data were collected only in Moscow and Yekaterinburg.

<sup>b</sup>Data were collected only in Bremen.

<sup>c</sup>Data collection, processing and/or analysis were disrupted by the COVID-19 pandemic and hence could not take place.

<sup>d</sup>Participation in Federation of BiH and Republika Srpska.

age for inclusion in the study. Measurements are generally conducted in primary schools, but there are some countries like Czechia and Finland where data collection is through the health system. In Czechia, for example, children are selected in pediatric clinics as part of the mandatory health checks performed by pediatricians.

Five countries—Belgium, Estonia, Israel, Malta, and San Marino—have included the entire population of a particular school grade or of particular age groups, whereas all other countries have selected a nationally representative sample. In Germany and the Russian Federation, the COSI sample was representative at sub-national level as data were collected only in Moscow and Ekaterinburg and in Bremen, respectively. Most countries have adopted a two-stage cluster sampling design, which usually has schools as the primary sampling units (PSUs) and classes as the secondary sampling units (SSUs) (clusters). In the fourth round of COSI data collection, of 33 countries that adopted a sampling approach, 17 have applied this sampling design, and 8 have adopted a cluster design with classes, schools, municipalities, or pediatric units as sampling units (see Supplementary Table S1). A small number of countries have adopted a cluster design with more than two stages or with two stages but different definition of PSUs and SSUs. In the fourth round of COSI, in one case (Finland) where COSI is integrated into existing national surveillance systems, measurements are extracted from the national register for primary healthcare. Several countries apply stratification. In the fourth round of data collection, for example, 21 countries stratified according to the geographical or administrative division of the country, the degree of urbanization of the child's residence or school, or the size of the school. More details on the sampling design adopted in each country and each round of data collection are provided elsewhere.<sup>9–11</sup>

The protocol specifies that the effective sample size—that is, the effective number of measured children—should be a minimum of 2800 children per target age group (1400 girls and 1400 boys), in order to have 80% power to detect a minimum difference of 0.10 Z-score in mean body mass index (BMI) per year at a two-sided 5% significance level, after adjusting for design effect of 1.2. In order to allow for the number of children not willing to participate in the study and/or not belonging to target age groups, the overall number of children approached should be higher than these minimum numbers. For example, if it estimated that 90% of children in the selected grade belong to the target age group, then this requires the enrolment of around 3100 children initially to achieve the minimum effective sample size of 2800 children. If we assume that 80% of subjects give consent, the overall number should be increased to around 3800. In addition, the number of school grades included in the study affects the overall number of children invited to participate. If most of the children in the targeted age group are in the same grade, the sample can be drawn within that grade level. If this is not the case, all grades in which most children from this age group are present should be sampled. In those countries where it is necessary to include two

consecutive grades to target one age group, the overall number of children that should be approached to reach the effective sample size almost doubles. Finally, the sample size should be considerably higher in countries wishing to obtain estimates at sub-national levels. For example, in Italy where the study aimed to have representative estimates at regional or local health unit level, the number of children invited to participate was over 50,000 in order to target two age groups.

Some countries (six in the fourth round of data collection, see Table S1) have decided to follow a sentinel approach, whereby the same schools are selected and participate in multiple rounds of data collection, but most countries select a new sample of schools for each round.

## 2.2 | Data collection

COSI data are collected using three record forms: the child record form (including anthropometric measurements), the school record form, and the optional family record form. It is mandatory for participating countries to collect data using the child record form and the school record form, but countries can decide whether or not to use the family record form. It is not always possible to use the school record form in those countries that integrated COSI into existing surveillance systems—this was the case for Finland and Sweden, for example, in the fourth round. Each record form includes a set of mandatory questions and a set of optional questions which countries can choose to administer. Although the family record form is optional, if countries decide to administer it, then certain specified questions must be included.

The original English-language WHO record forms and instructions are translated into local languages and are then back-translated to English by a second independent translator in order to check for discrepancies against the original version. Both translations should be performed by professional translators wherever possible.

### 2.2.1 | Child record form

The child record form is compiled by a trained examiner to register, as a minimum, each child's identification code, sex, date of birth or age in months, urbanization grade classification for the child's place of residence, whether or not the child ate breakfast on the day of measurement, date and time of measurement, measured bodyweight and height, and description of clothes worn when measured. See Table 2 for details of the mandatory and optional questions included on the child record form.

Children's bodyweight and height are measured in a private room at school by trained examiners using standardized procedures. Children are measured wearing normal, light indoor clothing. They are asked to take off shoes and socks as well as heavy clothing (e.g., coat,

**TABLE 2** Mandatory and optional topics covered in the child, school, and family record forms

Mandatory topics	Optional topics
<i>Child record form</i>	
<ul style="list-style-type: none"> <li>- Child's identification code</li> <li>- Sex</li> <li>- Date of birth or age in months</li> <li>- Urbanization grade of residence</li> <li>- Breakfast taken on the day of measurement</li> <li>- Date of measurement</li> <li>- Time of measurement</li> <li>- Weight</li> <li>- Height</li> <li>- Clothes worn when measured</li> </ul>	<ul style="list-style-type: none"> <li>- Child's name</li> <li>- Place of residence</li> <li>- Postal code</li> <li>- Population size</li> <li>- Region or municipality</li> <li>- Time of measurement in hour and minutes</li> <li>- Reason given by a child who does not give permission to be measured</li> <li>- Waist circumference</li> <li>- Hip circumference</li> </ul>
<i>School record form</i>	
<ul style="list-style-type: none"> <li>- School identification</li> <li>- Function of person completing form</li> </ul>	<ul style="list-style-type: none"> <li>- Further details of school name/location</li> </ul>
<i>Information on participating classes:</i>	
<ul style="list-style-type: none"> <li>- Number of children registered/measured per sampled class</li> <li>- Number of children who declined to be measured/were absent/whose parents did not give consent</li> </ul>	<ul style="list-style-type: none"> <li>- Number of classes per grade selected to participate</li> </ul>
<i>School environment:</i>	
<ul style="list-style-type: none"> <li>- Availability of outdoor playground area/indoor gym</li> <li>- Inclusion of physical education in school curriculum (and for which grade)</li> <li>- Frequency of physical education lessons</li> <li>- Inclusion of nutrition education in school curriculum</li> <li>- Organization of healthy lifestyle initiatives/projects</li> <li>- Access to certain food items and beverages on the school premises (sweetened and unsweetened beverages, fresh fruit, vegetables, sweet snacks, ice cream, savory snacks)</li> <li>- Availability of school canteen</li> <li>- Availability of vending machine where children can buy foods or beverages (other than water, fruits and vegetables)</li> <li>- Whether school is free from advertising and marketing of energy-dense and nutrient-poor foods and beverages</li> </ul>	<ul style="list-style-type: none"> <li>- Whether children are allowed to actively play in extreme weather conditions in outdoor playing areas</li> <li>- Whether children are allowed to use outdoor playground areas outside school hours</li> <li>- Whether children are allowed to use the indoor gym outside school hours</li> <li>- Organization of sport/physical activities for primary school children outside school hours at least once a week (and for which grades)</li> <li>- Children's attendance at such organized sport/physical activities</li> <li>- Availability of school bus transport (and for which pupils)</li> <li>- Opinion on safety of routes for walking or cycling to and from school</li> <li>- Availability of shop or cafeteria selling foods/beverages</li> </ul>
<i>Family record form (optional for participating countries)</i>	
<ul style="list-style-type: none"> <li>- Relationship of person completing questionnaire to child</li> <li>- Whether child was ever breastfed (and if so, duration)</li> <li>- Usual mode of travel to school</li> <li>- Child's membership of sport clubs or dancing courses</li> <li>- Time spent on sports and physical activity with sports clubs or dancing courses per week</li> <li>- Sleep duration on school days</li> <li>- Time spent playing actively or vigorously outside school hours (weekdays/weekends)</li> <li>- Time usually spent watching TV or playing with electronic devices outside school lessons (weekdays/weekends)</li> <li>- Frequency of having breakfast</li> <li>- Frequency of consumption of certain types of foods/beverages (fresh fruit, vegetables, soft drinks)</li> <li>- Respondent's assessment of child's weight status</li> <li>- Number of people living in household (and relationships to child)</li> <li>- Highest level of education of respondent parent/caregiver and their spouse/partner</li> </ul>	<ul style="list-style-type: none"> <li>- Child identification</li> <li>- Child's sex</li> <li>- Weight at birth</li> <li>- Whether child was born late, on time or early</li> <li>- Whether child was ever exclusively breastfed and duration</li> </ul>
<i>Child behavior characteristics:</i>	
	<ul style="list-style-type: none"> <li>- Distance between school and home</li> <li>- For child who does not use active travel (e.g., walking or cycling) to go to and from school, reasons for not doing so</li> <li>- Respondent's opinion of safety of routes for traveling to/from school by walking, cycling, skateboard or scooter</li> <li>- Time usually spent doing homework or reading a book (weekdays/weekends)</li> <li>- Frequency of consumption of additional types of foods/beverages (with sugar content of breakfast cereals recorded separately)</li> </ul>
<i>Household characteristics (respondent and household):</i>	
	<ul style="list-style-type: none"> <li>- Diagnosis of hypertension, diabetes, high cholesterol</li> <li>- Respondent and partner's weight, height and age</li> <li>- Child's country of birth</li> <li>- Child's parents' country of birth</li> <li>- Main language spoken with child in the home</li> <li>- Adequacy of monthly earnings to meet needs</li> <li>- Main occupation of respondent and partner</li> </ul>



pullover, jacket) and wallet, mobile phone, key chain, belts, and any other objects or ornaments. Examiners involved in COSI include the following:

- school nurses, physicians, or pediatricians linked to the school health system;
- other suitable school personnel, such as physical education teachers during physical education classes;
- health professionals taking measurements during routine comprehensive health screening or specifically for the surveillance initiative; or
- other examiners, including professionals with experience in this type of study and university students in the fields of health, nutrition, and sports.

In general, before each data collection round, examiners are trained to take and record standardized measurements as accurately and precisely as possible according to the gold standard measurement techniques described in the protocol. In cases where COSI is integrated into existing monitoring or measuring arrangements, the need for training is assessed on a case-by-case basis, and training specific to COSI is provided where necessary. The topics covered by the training include a review of the background and objectives of the surveillance system; standardized use of the forms; detailed instructions on taking measurements according to the protocol; supporting children who are anxious; calibrating instruments; recording measurements immediately after reading them; and legible, accurate, and contemporaneous recording of measurements. The need for strict adherence to the measurement techniques and recording procedures is also emphasized. Furthermore, the training highlights that it is important to ensure confidentiality, to prevent stigmatization or bullying of vulnerable children, and to be able to answer potential questions from children, school staff, or parents.

Countries are required to use the same highly accurate and precise anthropometric instruments. To measure bodyweight, portable electronic (digital) scales calibrated to 0.1 kg (100 g) and measuring up to 150 kg are used. Height is measured in centimeters to the last completed millimeter (0.1 cm). Height is measured using a height board mounted at a right angle between a level floor and a straight, vertical surface (if possible with a digital counter).

The COSI protocol specifies that, at the national level, anthropometric measurements have to be taken over as short a period as possible, preferably within 4 weeks and no longer than 10 weeks. In practice, however, it is recognized that in some circumstances it may not be possible to complete data collection within 10 weeks. According to the protocol, measurements should not take place during the first 2 weeks of a new school term or immediately after a major holiday and should preferably be taken in the morning before lunch, although the protocol also acknowledges that it is not always feasible to measure children in the morning.

## 2.2.2 | School record form

The school record form is completed by the school principal (head teacher), the teachers of the participating classes, or by another person who is able to provide the information required. Data on the school and the number of children registered and measured per sampled class, as well as the number of children who refused to be measured, whose parents did not give consent, or were absent are collected. A number of characteristics of the school environment are also included (Table 2).

## 2.2.3 | Optional family record form

Countries can choose to collect data on simple indicators of children's dietary intake, physical activity, sedentary behavior, and sleep patterns, as well as data on their families' socioeconomic characteristics and selected health conditions associated with overweight and obesity, through the family record form. Although inclusion of the family form is optional, if a country decides to adopt it, some of the questions are mandatory (Table 2). The form is completed by children's parents or caregivers as a self-administered questionnaire, either on paper or online.

## 2.2.4 | Electronic systems

In the first three rounds of COSI, data were collected using paper forms and were subsequently digitized following a common data codebook. Since the fourth round in 2015–2017, participating countries can use a dedicated electronic system, which also allows data to be entered directly into the system without the use of paper forms. The WHO-COSI electronic system was developed using the software Open Clinica (OpenClinica LLC, Waltham, MA, USA). The COSI family record form was also implemented in an online survey tool, using the open source statistical survey web app LimeSurvey (LimeSurvey GmbH, Hamburg, Germany), to allow families to complete it online. The online family form was created in the country's national language(s) including the option of choosing a preferred language for multilingual countries. Data gathered through LimeSurvey are automatically transferred to OpenClinica, where they are stored. In the first five rounds of data collection, 18 participating countries used the electronic system to record data.

## 2.3 | Data cleaning and analysis

Data quality assurance is first applied at the country level based on guidelines specifically developed for COSI data by the WHO Regional Office. All cleaned datasets are sent to the COSI team in the WHO Regional Office, where they are first reviewed to assess completeness and identify any inconsistencies before being merged for intercountry analyses.



In the fourth round of COSI data collection, sampling weights were estimated by the WHO Regional Office applying a common approach which included the following steps: (i) calculation of the design weights using the inclusion probability of each sampling unit at each stage; (ii) adjustment of the design weight for participation proportion among children invited to participate; (iii) adjustment to calibrate the final set of adjusted weights to the distribution of the population by certain characteristics (e.g., the child's sex/age group, the school grade, the region/administrative division, or the urbanization grade), which was provided by each country based on official statistics. The sampling weights were applied in intercountry analyses based on fourth round data. In previous rounds, sampling weights were available only for a few countries, and unweighted data analyses were carried out. The WHO Regional Office provides support to countries that request assistance with data checking and analysis procedures.

The classification of children's weight status is based on the BMI and WHO recommended growth reference for school-aged children and adolescents.<sup>12,13</sup> BMI is calculated using the following formula: weight (kg) divided by height squared ( $m^2$ ). During data analyses, body weight is adjusted for the weight of the clothes worn by the children when measured. According to WHO definitions, overweight and obesity are defined as a BMI-for-age value  $> +1$  Z-score and  $> +2$  Z-scores, respectively.<sup>12</sup> The estimated prevalence of overweight includes children with obesity.<sup>14</sup> Children with a biologically implausible (or extreme) BMI-for-age value are excluded from the analyses (values below  $-5$  or above  $+5$  Z-scores relative to the 2007 WHO growth reference median).<sup>13</sup> As the International Obesity Task Force (IOTF) cutoff points<sup>15</sup> are widely used in the WHO European Region, prevalences are also calculated using these cutoffs and can also be presented in reports and peer-reviewed publications.

## 2.4 | Ethical aspects

The WHO COSI study protocol conforms to the 2002 International Ethical Guidelines for Biomedical Research Involving Human Subjects,<sup>16</sup> and all national surveys have been approved by local ethics committees or other institutions in each country and comply with national legislation. Furthermore, the children's parents or guardians give their informed consent, and the child's verbal assent is always obtained before measurements are taken. Examiners take steps to ensure the basic principles of confidentiality, privacy, and objectivity are respected throughout the process.

The child's height and bodyweight are not routinely communicated to parents, but they are provided on request. Neither children nor parents are ever told the measurements of other children.

## 3 | RESULTS

The number of participating countries has increased from the initial 13 countries in the first round of data collection (2007–2008), to

17 in the second round (2009–2010), 22 in the third round (2012–2013), 38 in the fourth round (2015–2017), and 45 in the fifth round (2018–2020) (Table 1). Not all participating countries have collected data in all rounds, but nine countries have participated in every round to date. At the end of the fifth round of data collection, 34 countries had collected data (a further 5 countries had planned to collect data but were unable to do so, due to the COVID-19 pandemic). Over 940,000 children have been measured through the four rounds of data collection (Table 3). Preliminary data suggest that a further 400,000 children were measured during the fifth round of data collection. COSI established a new surveillance system in 35 countries, and COSI is linked to existing monitoring systems in 10 countries (Belgium, Czechia, Denmark, Finland, France, Israel, Netherlands, North Macedonia, Slovenia, and Sweden). In two countries, participation is by city rather than national authorities—namely, Bremen in Germany and Yekaterinburg and Moscow in the Russian Federation. Children aged 7 years are the most frequently targeted, followed by 8-year-olds. In the fourth edition of COSI, 17 countries targeted only 7-year-olds, seven targeted only 8-year-olds, two targeted only 9-year-olds, and 10 countries targeted more than one age group (see Figure 1).

Children's and parents' participation in the study has generally been very high (Table 3). In the third and fourth round of the study, for example, more than half of the participating countries had a participation proportion above 80%. In the fourth round, for example, in 13 countries 90% or more of the children invited to participate were measured, in 11 countries this proportion was between 80% and 89%, and in a further five countries it was between 70% and 79%.

There has been a steady increase in the number of countries administering the optional family form, increasing from 5 countries in the first round, 6 in the second, 11 in the third, 24 in the fourth, and 28 in the fifth. In the fourth round, over 90% of the parents of the children selected to participate filled out and returned the family form in four countries, and parental participation was between 80% and 89% in five countries and between 70% and 79% in eight countries. In six countries, parental participation rates were under 70%.

Detailed COSI findings are reported elsewhere.<sup>9–11,17</sup>

## 4 | DISCUSSION

Adoption of a common COSI protocol and standardized instruments and procedures has led to the establishment of a very effective surveillance system which provides regular, reliable, and valid data on children's weight status, as well as information on dietary intake, physical activity, sedentary behavior, family background, and school environments.

The systematic collection and analysis of these data has enabled valuable intercountry comparisons; highlighted differences in the distribution of childhood thinness, normal weight, overweight, and obesity between and within populations; facilitated the exploration of the relationship between overweight and potential risk or protective factors; and improved the understanding of the progression of this public

**TABLE 3** Country and child participation in five rounds of COSI data collection

Data collection round	Data collection period	Countries where COSI data collection took place	Target age groups: Number of countries	Numbers of measured children (children belonging to target age groups)	Proportion of children invited to participate that were measured: Number of countries	Countries that administered the COSI family questionnaire	Proportion of children invited to participate whose parents or caregiver completed the family form (families' participation proportion)
1 <sup>st</sup> round	2007–2008	12 countries: Belgium; Bulgaria; Czechia; Ireland; Italy; Latvia; Lithuania; Malta; Norway; Portugal; Slovenia; Sweden	6.00–6.99: 3 7.00–7.99: 9 8.00–8.99: 5 9.00–9.99: 2	178,173 (168,813)	≥90%: 3 80–89%: 5 70–79%: 3 60–69%: none 50–59%: none <50%: none N/A: 1	5 countries: Bulgaria; Czechia; Lithuania; Portugal, Sweden	≥90%: 1 80–89%: none 70–79%: 2 60–69%: 1 50–59%: none <50%: none N/A: none
2 <sup>nd</sup> round	2009–2010	14 countries: Belgium; Czechia; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Malta; North Macedonia; Norway; Portugal; Slovenia; Spain	6.00–6.99: 4 7.00–7.99: 11 8.00–8.99: 5 9.00–9.99: 7	239,620 (227,222)	≥90%: 4 80–89%: 4 70–79%: 2 60–69%: 1 50–59%: 1 <50%: 1 N/A: 1	6 countries: Czechia; Hungary; Italy; Lithuania; Portugal; Spain	≥90%: 1 80–89%: 3 70–79%: 1 60–69%: none 50–59%: 1 <50%: none N/A: none
3 <sup>rd</sup> round	2012–2013	19 countries: Albania; Belgium; Bulgaria; Czechia; Greece; Ireland; Italy; Latvia; Lithuania; Malta; North Macedonia; Norway; Portugal; Republic of Moldova; Romania; San Marino; Slovenia; Spain; Turkey	6.00–6.99: 3 7.00–7.99: 13 8.00–8.99: 9 9.00–9.99: 6	272,561 (254,409)	≥90%: 6 80–89%: 5 70–79%: 3 60–69%: none 50–59%: 2 <50%: none N/A: 4	11 countries: Bulgaria; Czechia; Ireland; Italy; Lithuania; Malta; Portugal; Republic of Moldova; San Marino; Spain; Turkey	≥90%: 3 80–89%: 2 70–79%: 2 60–69%: 2 50–59%: 1 <50%: none N/A: 1
4 <sup>th</sup> round	2015–2017	36 countries: Albania; Austria; Bulgaria; Croatia; Cyprus; Czechia; Denmark; Estonia; Finland; France; Georgia; Greece; Hungary; Ireland; Italy; Kazakhstan; Kyrgyzstan; Latvia; Lithuania; Malta; Montenegro; North Macedonia; Norway; Poland; Portugal; Romania; Russian Federation <sup>a</sup> ; San Marino;	6.00–6.99: 3 7.00–7.99: 25 8.00–8.99: 15 9.00–9.99: 8	250,336 (203,687)	≥90%: 13 80–89%: 11 70–79%: 5 60–69%: 1 50–59%: 1 <50%: 1 N/A: 4	24 countries: Albania; Bulgaria; Croatia; Czechia; Denmark; France; Georgia; Ireland; Italy; Kazakhstan; Kyrgyzstan; Latvia; Lithuania; Malta; Montenegro; Poland; Portugal; Romania; Russian Federation <sup>a</sup> ; San Marino; Spain; Tajikistan; Turkey; Turkmenistan	≥90%: 4 80–89%: 5 70–79%: 8 60–69%: 2 50–59%: 1 <50%: 3 N/A: 1

(Continues)

TABLE 3 (Continued)

Data collection round	Data collection period	Countries where COSI data collection took place	Target age groups: Number of countries	Numbers of measured children (children belonging to target age groups)	Proportion of children invited to participate that were measured: Number of countries	Countries that administered the COSI family questionnaire	Proportion of children invited to participate whose parents or caregiver completed the family form (families' participation proportion)
5 <sup>th</sup> round	2018–2020	Serbia; Slovakia; Slovenia; Spain; Sweden; Tajikistan; Turkey; Turkmenistan	Not yet available	Not yet available	Not yet available	28 countries: Armenia; Austria; Bulgaria; Croatia; Czechia; Denmark; Estonia; Germany; Georgia; Greece; Hungary; Ireland; Italy; Kazakhstan; Latvia; Lithuania; Malta; Montenegro; North Macedonia; Poland; Portugal; Romania; Russian Federation <sup>d</sup> ; San Marino; Serbia; Slovakia; Slovenia; Spain; Sweden; Tajikistan	Not yet available

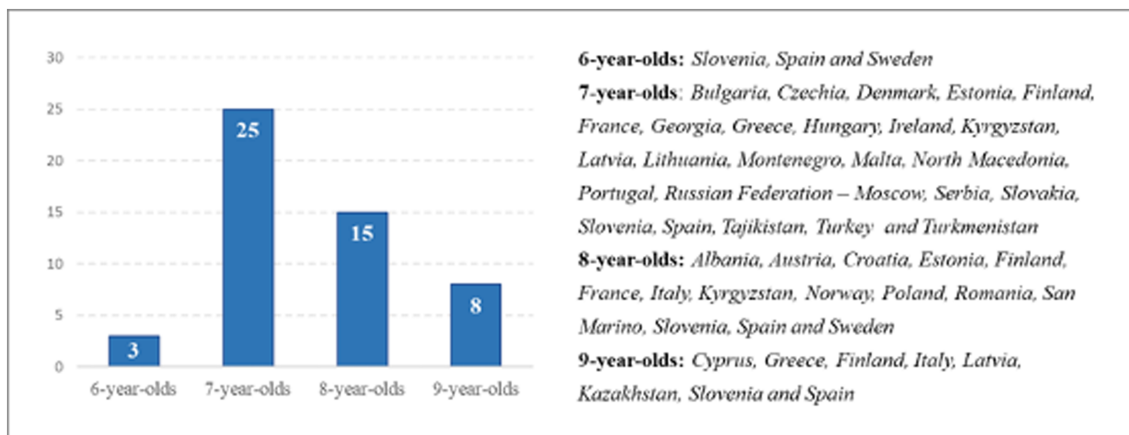
Note: N/A: Information not available.

<sup>a</sup>Moscow only.

<sup>b</sup>Data collection was planned in Azerbaijan, Bosnia and Herzegovina, Netherlands, Turkmenistan and Uzbekistan but was unable to take place due to the COVID-19 pandemic.

<sup>c</sup>Bremen only.

<sup>d</sup>Moscow and Yekaterinburg only.



**FIGURE 1** Number of countries by targeted age groups. WHO COSI round 4 (2015/2017)

health challenge in Europe.<sup>9–11,17–21</sup> It is now clear that these data and analyses have informed the development of policy action in many European countries.<sup>22</sup>

A key challenge for COSI has been to establish methods and procedures which are simple and pragmatic, yet valid and standardized to thus enable comparisons between countries, but which are at the same time appropriate for the very different contexts within the region and flexible enough to enable participation of as many countries as possible. The common protocol, which has evolved over the years since COSI was launched, seeks to define the limits within which each participating country can create a surveillance system that both matches its own needs and allows comparisons with those of the other countries. This flexibility has allowed several countries to integrate COSI into existing national surveillance systems.

Coordination by the WHO Regional Office for Europe and provision of technical support and assistance—by the Regional Office, experienced COSI members, and other partners—contributes to ensuring the quality of the data. The fact that all examiners are trained to measure children's height and bodyweight—most of them receive training before the start of a data collection round—helps to reduce variability between examiners. The use of standardized instruments—namely, weight scales and stadiometers—also helps ensure the high-quality data.

There are challenges in ensuring comparability of survey forms which are applied across widely differing contexts and a variety of cultures and in many different languages. The highly standardized training, quality assurance, and inclusion in the protocol of a requirement to have a second translator back-translate the local language forms into English in order to check for discrepancies against the original English version is an important safeguard against such challenges.

Negative attitudes about bodyweight, which can result in harmful stigma or weight bias or obesity stigma, are common in Europe,<sup>23</sup> and it is important to minimize the risk of stigmatization or any other harm to children participating in COSI. Measures to minimize such risks include provision of training on the prevention of stigmatization for COSI examiners who are not already trained on such issues and strong

emphasis in the protocol on the need to respect the basic principles of confidentiality, privacy, and objectivity.

Given the variation in participation rates, there remains scope for improvement in some countries to improve the participation proportion in order to avoid potential problems of selection bias and ensure the representativeness of samples.

The fifth round of data collection, between 2018 and 2020, has been disrupted in several locations due to the COVID-19 pandemic and the resulting school closures in many countries. The possibility of ongoing restricted access to schools, combined with the necessity of in-person contact between the examiners and the children, present particular challenges for COSI implementation during the pandemic. It remains to be seen how these restrictions will change over the coming years, but it is important to resume regular and representative data collection as soon as possible. This will ensure continued provision of essential surveillance data and will also be important for helping to assess the long-term impacts of COVID-19 on child weight status across Europe.

## 5 | CONCLUSION

The establishment of COSI and the adoption of a common methodology across participating countries has resulted in a surveillance system which provides regular, reliable, and valid data on children's weight status and related information in the WHO European Region. Four rounds of data collection over the first 10 years of COSI have yielded data, including measured anthropometric data, on over 940,000 children. Learning from the experience with these rounds of data collection has enabled further improvements and standardization of COSI procedures. The systematic collection and analysis of these data, supplemented by contextual data on home and school environments, enables essential intercountry comparisons and monitoring of overweight and obesity in primary school-age children in the WHO European Region in order to inform appropriate and effective policy responses.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest. The funders played no role in the design of the COSI protocol, the decision to write this paper, or its content.

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## DISCLAIMER

JB, JW, FB, MW and IR are staff members of WHO, and MB and KM are consultants with WHO. The authors alone are responsible for the views expressed in this article, and they do not necessarily represent the views, decisions, or policies of the institutions with which they are affiliated.

## ETHICAL APPROVAL

The COSI study follows the International Ethical Guidelines for Biomedical Research Involving Human Subjects. Local ethics approval was also granted.

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## SUPPORTING INFORMATION

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

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