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# Physical Activity, Screen Time, and Sleep Duration of Children Aged 6–9 Years in 25 Countries: An Analysis within the WHO European Childhood Obesity Surveillance Initiative (COSI) 2015–2017

Stephen Whiting<sup>a,b</sup> Marta Buoncristiano<sup>a</sup> Peter Gelius<sup>c</sup> Karim Abu-Omar<sup>c</sup> Mary Pattison<sup>a</sup>  
Jolanda Hyska<sup>d</sup> Vesselka Duleva<sup>e</sup> Sanja Musić Milanović<sup>f</sup> Hana Zamrazilová<sup>g</sup>  
Tatjana Hejgaard<sup>h</sup> Mette Rasmussen<sup>i</sup> Eha Nurk<sup>j</sup> Lela Shengelia<sup>k</sup> Cecily C. Kelleher<sup>l</sup>  
Mirjam M. Heinen<sup>l</sup> Angela Spinelli<sup>m</sup> Paola Nardone<sup>m</sup> Akbota Abildina<sup>n</sup>  
Shynar Abdrakhmanova<sup>n</sup> Gulmira Aitmurzaeva<sup>o</sup> Zhamyila Usuopva<sup>o</sup> Iveta Pudule<sup>p</sup>  
Aušra Petrauskienė<sup>q</sup> Victoria Farrugia Sant'Angelo<sup>r</sup> Enisa Kujundžić<sup>s</sup> Stevo Popović<sup>t</sup>  
Anne-Siri Fismen<sup>u</sup> Ingunn Holden Bergh<sup>v</sup> Anna Fijalkowska<sup>w</sup> Ana Isabel Rito<sup>x</sup>  
Alexandra Cucu<sup>y</sup> Lacramioara Aurelia Brinduse<sup>z</sup> Valentina Peterkova<sup>A</sup> Andrea Gualtieri<sup>B</sup>  
Marta García-Solano<sup>C</sup> Enrique Gutiérrez-González<sup>C</sup> Zulfinissio Abdurrahmonova<sup>D</sup>  
Khadichamo Boymatova<sup>E</sup> Nazan Yardim<sup>F</sup> Maya Tanrygulyeva<sup>G</sup> Daniel Weghuber<sup>H</sup>  
Karin Schindler<sup>I</sup> Dragana Stojisavljević<sup>J</sup> Aida Filipović Hadžiomerađić<sup>K</sup>  
Eliza Markidou Ionnaidu<sup>L</sup> Wolfgang Ahrens<sup>M</sup> Maria Hassapidou<sup>N</sup> Viktoria Anna Kovacs<sup>O</sup>  
Sergej M. Ostojic<sup>P</sup> Lubica Ticha<sup>Q</sup> Gregor Starc<sup>R</sup> Kenisha Russell Jonsson<sup>S</sup> Igor Spiroski<sup>T</sup>  
Harry Rutter<sup>U</sup> Romeu Mendes<sup>a,b</sup> Julianne Williams<sup>a</sup> Ivo Rakovac<sup>a</sup> João Breda<sup>a</sup>

<sup>a</sup>WHO European Office for the Prevention and Control of NCDs, Moscow, Russian Federation; <sup>b</sup>EPIUnit – Instituto de Saúde Pública, Universidade do Porto, Porto, Portugal; <sup>c</sup>Department of Sport Science and Sport, FAU, Erlangen, Germany; <sup>d</sup>Nutrition and Food Safety Sector, Institute of Public Health, Tirana, Albania; <sup>e</sup>National Center of Public Health and Analyses, Sofia, Bulgaria; <sup>f</sup>School of Medicine, University of Zagreb, Croatian Institute of Public Health, Zagreb, Croatia; <sup>g</sup>Institute of Endocrinology, Obesity Management Centre, Prague, Czechia; <sup>h</sup>Danish Health Authority, Copenhagen, Denmark; <sup>i</sup>National Institute of Public Health, University of Southern Denmark, Copenhagen, Denmark; <sup>j</sup>National Institute for Health Development, Tallinn, Estonia; <sup>k</sup>National Center for Disease Control and Public Health, Tbilisi, Georgia; <sup>l</sup>National Nutrition Surveillance Centre, University College Dublin, Dublin, Ireland; <sup>m</sup>Italian National Institute of Health, Rome, Italy; <sup>n</sup>National Centre of Public Health of the Ministry of Health of the Republic of Kazakhstan, Nur-Sultan, Kazakhstan; <sup>o</sup>Republican Centre for Health Promotion, Bishkek, Kyrgyzstan; <sup>p</sup>Ministry of Health, Centre for Disease Prevention and Control, Riga, Latvia; <sup>q</sup>Lithuanian University of Health Sciences, Health Research Institute and Department of Preventive Medicine, Kaunas, Lithuania; <sup>r</sup>Primary Health Care, Floriana, Malta; <sup>s</sup>Institute of Public Health of Montenegro, Podgorica, Montenegro; <sup>t</sup>Faculty for Sport and Physical Education, University of Montenegro, Niksic, Montenegro; <sup>u</sup>Department of Health Promotion, Norwegian Institute of Public Health, Bergen, Norway; <sup>v</sup>Department of Health and Inequality, Division of Mental and Physical Health, Norwegian Institute of Public Health, Bergen, Norway; <sup>w</sup>Department of Cardiology, Institute of Mother and Child, Warsaw, Poland; <sup>x</sup>National Institute of Health Dr Ricardo Jorge I.P., Lisbon, Portugal; <sup>y</sup>National Institute of Public Health, Bucharest, Romania; <sup>z</sup>University of Medicine and Pharmacy Carol Davila, Bucharest, Romania;

<sup>A</sup>The Endocrine Research Centre, Moscow, Russian Federation; <sup>B</sup>Health Authority San Marino, San Marino, Republic of San Marino; <sup>C</sup>Spanish Agency for Food Safety and Nutrition, Ministry of Health, Madrid, Spain; <sup>D</sup>Republican Centre for Nutrition, Ministry of Health and Social Protection of Population, Dushanbe, Tajikistan; <sup>E</sup>WHO Tajikistan Country Office, Dushanbe, Dushanbe, Tajikistan; <sup>F</sup>Diabetes and Metabolic Disorders Department, Ministry of Health, Public Health Institution, Ankara, Turkey; <sup>G</sup>Scientific Research Institute of Maternal and Child Health, Ashgabat, Turkmenistan; <sup>H</sup>Department of Pediatrics, Paracelsus Medical University, Salzburg, Austria; <sup>I</sup>Medical University of Vienna, Vienna, Austria; <sup>J</sup>Public Health Institute of Republic of Srpska, the University of Banja Luka, Faculty of Medicine, Banja Luka, Bosnia and Herzegovina; <sup>K</sup>Institute of Public Health of Federation of Bosnia and Herzegovina, Banja Luka, Bosnia and Herzegovina; <sup>L</sup>Ministry of Health, Limassol, Cyprus; <sup>M</sup>Leibniz Institute for Prevention Research and Epidemiology – BIPS, Bremen, Institute of Statistics, University of Bremen, Bremen, Germany; <sup>N</sup>International Hellenic University, Thessaloniki, Greece; <sup>O</sup>Hungarian School Sport Federation, Budapest, Hungary; <sup>P</sup>Faculty of Sport and PE, University of Novi Sad, Novi Sad, Serbia; <sup>Q</sup>National Institute of Children Diseases, Medical Faculty of Comenius University, Bratislava, Slovakia; <sup>R</sup>Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia; <sup>S</sup>Department of Living Conditions and Lifestyle, Public Health Agency of Sweden, Solna, Sweden; <sup>T</sup>Department of Physiology and Monitoring of Nutrition, Institute of Public Health, Skopje, Republic of Macedonia; <sup>U</sup>Department of Social and Policy Sciences, University of Bath, Bath, UK

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## Keywords

Physical inactivity · Surveillance · Sedentary behaviour · Active transport, active play

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## Abstract

**Background:** Children are becoming less physically active as opportunities for safe active play, recreational activities, and active transport decrease. At the same time, sedentary screen-based activities both during school and leisure time are increasing. **Objectives:** This study aimed to evaluate physical activity (PA), screen time, and sleep duration of girls and boys aged 6–9 years in Europe using data from the WHO European Childhood Obesity Surveillance Initiative (COSI). **Method:** The fourth COSI data collection round was conducted in 2015–2017, using a standardized protocol that included a family form completed by parents with specific questions about their children's PA, screen time, and sleep duration. **Results:** Nationally representative data from 25 countries was included and information on the PA behaviour, screen time, and sleep duration of 150,651 children was analysed. Pooled analysis showed that: 79.4% were actively playing for >1 h each day, 53.9% were not members of a sport or dancing club, 50.0% walked or cycled to school each day, 60.2% engaged in screen time for <2 h/day, and 84.9% slept for 9–11 h/night. Country-specific analyses of these behaviours showed pronounced differences, with national prevalences in the range of 61.7–98.3% actively playing for >1 h/day, 8.2–85.6% were not members of a sport or dancing club, 17.7–94.0% walked or cycled to school each day, 32.3–80.0% engaged in screen time for <2 h/day, and 50.0–95.8%

slept for 9–11 h/night. **Conclusions:** The prevalence of engagement in PA and the achievement of healthy screen time and sleep duration are heterogenous across the region. Policymakers and other stakeholders, including school administrators and parents, should increase opportunities for young people to participate in daily PA as well as explore solutions to address excessive screen time and short sleep duration to improve the overall physical and mental health and well-being of children.

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## Background

During childhood, adequate levels of physical activity (PA) are fundamental for the development of basic cognitive, motor, and social skills, as well as musculoskeletal, cardiovascular, and metabolic health [1]. PA is an important determinant in the prevention and treatment of childhood obesity and early metabolic risk factors [2, 3]. Childhood obesity is associated with many serious health problems [4, 5] including psychosocial consequences [6–9] and it increases the risk for noncommunicable diseases (NCDs) later in life [10]. PA levels during childhood also tend to track into adolescence and adulthood [10, 11], so establishing healthy PA behaviours during childhood can reap dividends in later life [12].

The World Health Organisation (WHO), through the Global Action Plan for Physical Activity 2018–2030 [13] and the Physical Activity Strategy for the WHO European

Region 2016–2025 [14], provides guidance and support for countries to promote regular PA as a preventative measure to help reduce a wide variety of health risk factors across all ages, genders, ethnicities, and socioeconomic subgroups. Current WHO recommendations for children and adolescents aged 5–17 years are to accumulate at least 60 min of moderate/vigorous-intensity PA (MVPA) per day to maintain good physical and mental health and well-being [1]. Active play (unstructured, outdoor physical activity in children's free time), active transport (cycling or walking) and participating in sports are the major contributors to total PA among children.

It is important that, as children grow and develop, in addition to high levels of PA, they also achieve low levels of sedentary behaviour (SB) and get enough sleep each day. Time spent using screen-based devices increases SB which has been linked with a higher intake of energy-dense snacks and drinks and fast foods, and an overall higher energy intake [15]. Short sleep duration has also been linked with the development of obesity [16] and high blood pressure in children [17] as well as with overall well-being [18]. In recent years and based on evidence of the importance of SB and sleep to health, several countries have shifted to providing integrated guidance for movement behaviours across the whole day (i.e., a 24-h period) including recommendations for PA, screen time, and sleep duration [19–21].

The COSI (Childhood Obesity Surveillance Initiative) system is unique as it involves taking standardised weight and height measurements of children, providing nationally representative data for participating countries and a large region-wide dataset for analysing the determinants of childhood overweight and obesity. It includes a questionnaire that measures the PA, screen time, and sleep duration of children, a voluntary element for the participating countries, which is completed by a child's family member (usually a parent). Comparable data on PA-related behaviours among children in Europe is limited as countries use a range of approaches, including parent/caregiver report measures (e.g., questionnaires) and objective measures (e.g., accelerometers). While there are weaknesses to using parent/caregiver report questionnaires, one of their strengths is the collection of a wide range of sociodemographic and health-related behaviours of study participants by means of a single tool from large nationally representative samples. Objective measures of PA have thus far not been integrated with the COSI system due to the costs involved for the participating countries as well as the added complication to the implementation of a survey where the primary outcome is

nationally representative data on childhood overweight and obesity; information on PA, screen time, and sleep are just 3 of many secondary outcomes.

This study aimed to describe overall and cross-national comparisons of PA, screen time, and sleep duration of girls and boys aged 6–9 years using data collected as part of the COSI study in 2015–2017 in 25 countries of the WHO European Region. An analysis of this unique dataset provides new insights and includes many countries where there is currently limited data on these behaviours.

## Methods

The fourth COSI (COSI round 4) data collection was conducted in 36 countries in the school years 2015/2016 and 2016/2017 (2017/2018 for Kyrgyzstan). Information on children's PA, screen time, and sleep duration was collected via a paper questionnaire (i.e., the COSI family form) that was completed by a parent or caregiver [22]. Use of the family form is an optional part of the study and, of the 36 countries that participated, 24 included it in their national protocol which provided the data used in this study. One additional country, Estonia, did not use the family form but collected data by asking the children directly. The Estonian data is thus presented here but was not included in the pooled estimates.

### *Study Design and Sampling*

The data collection followed a standard protocol developed in 2007 by the WHO Regional Office for Europe, together with its member states, which was then slightly amended for the COSI rounds 2, 3, and 4 [23–26]. The COSI data collections have followed the International Ethics Guidelines for Biomedical Research Involving Human Subjects [27] and national ethics committees approved all national study protocols.

According to the COSI protocol, countries could choose  $\geq 1$  of the following age groups: 6.0–6.9, 7.0–7.9, 8.0–8.9, and 9.0–9.9 years. Most of the countries targeted only the 7-year-olds, or also  $\geq 1$  other age group. In almost all countries, the participating children were enrolled in primary school and were then randomly selected to create a nationally representative sample. More details on the main characteristics of the study design in each country are provided in the online supplementary Table 1 (for all online suppl. material, see [www.karger.com/doi/10.1159/000511263](http://www.karger.com/doi/10.1159/000511263)) and elsewhere [28].

### *Data Elaboration*

Information from the COSI family form included the following 5 behaviours: transportation to and from school, membership of a sport or dancing club and time spent practising these, time spent actively playing, time spent watching TV or using electronic devices, and the number of hours of sleep per night.

Table 1 shows the questions of interest and their predefined answer options for each of the categorical variables included in the analysis. In some cases, answer options were collapsed into broader categories to facilitate comparisons between countries. The WHO Regional Office for Europe collected data from all countries using a common format and carried out a data-cleaning process to

**Table 1.** PA, screen time, and sleep duration data collected by means of the 4th COSI family form (COSI/WHO Europe round 4 2015–2017)

Questions	Answer options	Categorization of responses
<p><i>Transportation to and from school<sup>b</sup></i> How does your child usually get to and from school? Please tick one option that he or she uses the most</p>	<p>Walking or cycling; Motorized vehicles; A combination of walking/cycling and motorised vehicles</p>	<p>Walking or cycling; Motorized vehicles; A combination of walking/cycling and motorized vehicles</p>
<p><i>Time spent practising sports<sup>b</sup></i> Is your child a member of one or more sports clubs or dancing courses (e.g., football, soccer, running, hockey, swimming, tennis, basketball, gymnastics, ballet, fitness, ballroom dancing)? Over a typical week (including weekends), how many hours does your child spend on sports and physical activities with these sport clubs or dancing courses?</p>	<p>Yes/No (if yes, continue to the next question) None; 1 h/week; 2 h/week; 3 h/week; 4 h/week; 5 h/week; 6 h/week; 7 h/week; 8 h/week; 9 h/week; 10 h/week; 11 h/week or more</p>	<p>No membership at sport/dancing clubs; 1–3 h a week spent on sports; 4 or more hours a week spent on sports</p>
<p><i>Time spent on actively/vigorously playing<sup>c</sup></i> In his/her free time, about how many hours per day is your child usually playing actively/vigorously (e.g., running and jumping outside, or moving and fitness games inside)? Please tick one box for weekdays and one box for weekend</p>	<p>Weekdays/Weekend; Not at all; Less than 1 h/day; About 1 h/day; About 2/day; About 3 or more hours/day</p>	<p>Not at all or less than 1 h/day; 1–2 h/day; More than 2 h/day<sup>d</sup></p>
<p><i>Time spent watching TV or using electronic devices<sup>c</sup></i> Outside school lessons, how much time does your child usually spend watching TV or using electronic devices such as a computer, tablet, or smartphone (not including moving or fitness games), either at home or outside the home (e.g., at an Internet cafe, game centre, etc.)? Please tick one for the weekdays and one for the weekend</p>	<p>Weekdays/Weekend; Not at all; – Number of hours/day</p>	<p>Not at all or less than 1 h/day; About 1 h/day; About 2 h/day; About 3 h/day or more<sup>e</sup></p>
<p><i>Hours of sleep per night<sup>g</sup></i> At what time does your child usually go to bed on school days (weekdays)? At what time does your child usually wake up on school days (weekdays)?</p>	<p>hour/minute; hour/minute</p>	<p>At least 9 h per night; At least 10 h per night; At least 11 h per night</p>

COSI, Childhood Obesity Surveillance Initiative.

<sup>a</sup> Data on transportation to and from school was not available for Italy and San Marino.

<sup>b</sup> For France, Ireland, Italy, and San Marino, information about children's membership at sports/dancing clubs was available, but there was no data on time spent practising sports in these clubs.

<sup>c</sup> Data on time spent playing actively/vigorously were not collected in Estonia and France. In Italy and San Marino, only the information about children never playing or playing for <1 h/day was available.

<sup>d</sup> Numerical values are assigned to the items "playing actively/vigorously on a weekday" and "playing actively/vigorously on a weekend day," enabling the conversion of this item to a numerical scale ("never" = 0; <1 h/day = 0.5; about 1 h/day = 1; about 2 h/day = 2; about ≥3/day = 3). Usual play time per day is calculated weighing weekday (5/7) and weekend hours (2/7) accordingly.

<sup>e</sup> Data on time spent watching TV or using electronic devices was not available for Estonia and Ireland.

<sup>f</sup> Number of hours per day is calculated weighing weekday (5/7) and weekend hours (2/7) accordingly.

<sup>g</sup> Data on hours of sleep per night was not available for Estonia and France.

**Table 2.** The number of children invited to participate in COSI/WHO Europe round 4 2015/2017, the proportions whose parents completed the family forms, the number of children included in the final analysis, and their demographic characteristics by country

Country <sup>a</sup>	Children invited to participate <sup>b</sup>		Children included in the analysis <sup>c</sup>			Distribution of children by sex and age <sup>d</sup> , %				
	Total, <i>n</i>	family form completed, %	boys, <i>n</i>	girls, <i>n</i>	total, <i>n</i>	boys	6 years	7 years	8 years	9 years
ALB	7,113	36.2	1,315	1,212	2,527	52.5	0.1	24.2	52.0	23.7
BUL	4,090	83.1	1,702	1,698	3,400	51.5	0.0	100	0.0	0.0
CRO <sup>e</sup>	7,220	76.0	1,318	1,333	2,651	51.1	0.0	0.0	100	0.0
CZH	n.a.	n.a.	670	736	1,406	50.7	49.5	50.5	0.0	0.0
DEN	3,202	29.9	511	446	957	52.7	27.4	70.2	2.4	0.0
EST	14,038	91.9	6,598	6,246	12,844	51.4	0.2	48.9	49.8	1.1
FRA	7,094	75.6	2,649	2,669	5,318	50.0	5.5	36.6	43.7	14.1
GEO	4,143	78.4	1,667	1,579	3,246	51.2	1.6	85.1	13	0.3
IRE	2,704	32.4	438	436	874	52.6	38.2	60.2	1.6	0.0
ITA	50,902	95.2	22,425	21,271	43,696	51.5	0.0	0.6	66.3	33.1
KAZ	6,026	82.3	2,149	2,162	4,311	50.6	0.0	0.4	51	48.6
KGZ	8,773	86.6	3,798	3,769	7,567	50.7	10.5	43.5	39.5	6.5
LTU	5,527	69.8	1,930	1,882	3,812	50.6	0.4	66.4	33	0.2
LVA	8,143	71.5	2,752	2,955	5,707	48.2	7.9	43.8	9.1	39.3
MAT	4,329	73.4	1,589	1,590	3,179	50.0	0.1	69.7	30.1	0.1
MNE	4,094	66.8	1,441	1,295	2,736	52.8	31.2	48.4	20.1	0.2
POL	3,828	76.9	1,451	1,494	2,945	50.2	0.0	0.0	100.0	0.0
POR	7,475	85.6	3,167	3,224	6,391	50.7	25.2	49.0	24.0	1.7
ROM	9,094	73.6	3,312	3,298	6,610	49.1	0.4	28.4	47.5	23.8
RUS	3,900	52.6	1,006	1,046	2,052	50.2	18.8	72.8	8.3	0.1
SMR	329	93.6	138	168	306	45.1	0.0	0.0	64.7	35.3
SPA	14,908	70.1	5,290	5,163	10,453	50.9	25.4	25.2	24.9	24.6
TJK	3,502	93.5	1,623	1,647	3,270	51.6	7.7	90.8	1.4	0.2
TKM	4,085	95.3	1,944	1,947	3,891	49.9	0.0	79.9	20.1	0.0
TUR	14,164	81.7	5,335	5,167	10,502	50.9	11.4	82.3	6.0	0.3
Total	198,683	79.5	76,218	74,433	150,651	51.3	0.0	45.7	48.6	5.7

n.a., not available.

<sup>a</sup> Figures refer to primary school children from: Albania (ALB); Bulgaria (BUL); Croatia (CRO); Czechia (CZH); Denmark (DEN); France (FRA) Georgia (GEO); Italy (ITA); Kazakhstan (KAZ); Kyrgyzstan (KGZ); Lithuania (LTU); Latvia (LVA); Malta (MAT); Montenegro (MNE); Poland (POL); Portugal (POR); Romania (ROM); Moscow city (RUS); San Marino (SMR); Spain (SPA); Tajikistan (TJK); Turkmenistan (TKM) and Turkey (TUR).

<sup>b</sup> Total figures were calculated including only countries with available information about the number of children invited to participate in the surveillance. The Estonian percentage refers to the proportion of child's form filled in, as the family form was not used in the 4th round of COSI and questions about PA patterns were put to children directly, not to parents/caregivers.

<sup>c</sup> All children with complete information on sex, aged 6–9 years, and with information about physical activity, sedentary behaviour, and sleep duration from the family form.

<sup>d</sup> Pooled values were estimated including the following age groups/countries: 7-year-olds from Bulgaria, Czechia, Denmark, Estonia, Kyrgyzstan, Georgia, Ireland, Latvia, Lithuania, Malta, Montenegro, Portugal, Spain, Tajikistan, Turkey, and Turkmenistan; 8-year-olds from Albania, Croatia, Italy, France, Poland, Romania, and San Marino; and 9-year-olds from Kazakhstan. The figures were estimated by applying post-stratification weights.

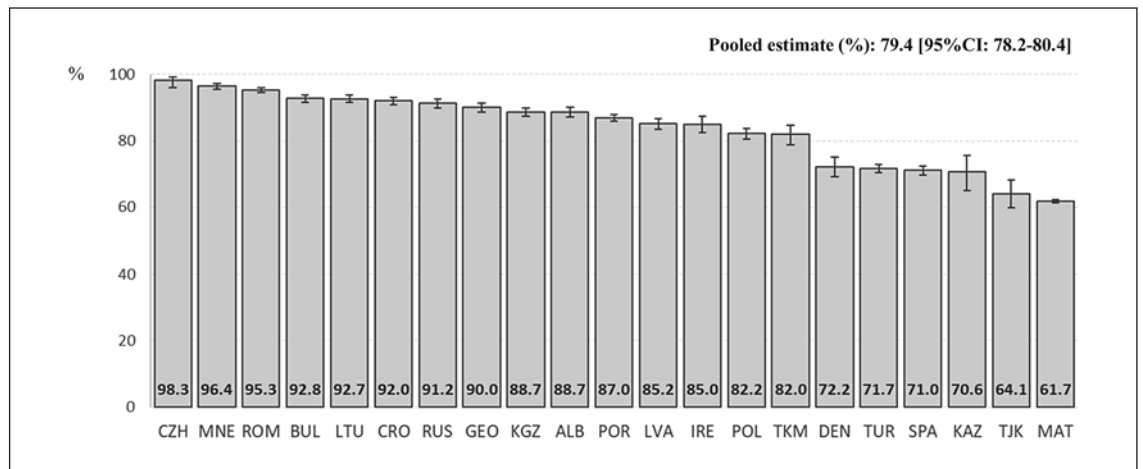
<sup>e</sup> For Croatia, only data on 8-year-olds was available for comparison at the European level. The proportion of children whose parents or caregivers filled in the family form was calculated in the whole sample (i.e., not only for 8-year-olds).

detect and correct inaccurate information (e.g., incoherent and/or out-of-range values, outliers, etc.) using the same procedures for all countries. After this process, the country datasets were merged together for the purpose of running inter-country analyses.

#### Statistical Analysis

The percentage distribution of children by each variable of interest was estimated for boys and girls separately and collectively.

To determine differences in distributions by a child's sex, we employed the two-tailed Pearson  $\chi^2$  test corrected with the Rao-Scott method. A *p* value of 0.05 was used to define statistical significance. Data analysis was conducted at the country level and by pooling data from all countries. Pooled estimates were calculated and included one target age group per country. This was done to balance the contribution of each country to the pooled estimates, while limiting the differences in age groups included between countries.



**Fig. 1.** Pooled and country-specific estimates (along with their 95% confidence intervals) of the percentage of children actively playing for at least 1 h/day (COSI/WHO Europe round 4 2015–17).

For the pooled analysis, the 7-year-old age group was used if the country targeted this age group. Otherwise, the nearest target age group was included.

Pooled estimates on PA, screen time, and sleep duration were then calculated. Data from all countries that strictly followed the COSI protocol was included in the pooled estimates, except for the data obtained in Moscow as this was not representative of the whole country.

Post-stratification weights to adjust for sampling design, over-sampling, and non-response were available for all countries that applied a sampling approach; Lithuania was excluded. These weights were used in all analyses to infer the results from the sample to the population. For Lithuania, an unweighted analysis was carried out. In the pooled analysis, an adjusting factor was applied to the post-stratification weights to take into consideration differences between country population sizes. The adjusting factor was calculated based on the number of children belonging to the targeted age group according to Eurostat figures or official national statistics for 2016. All analyses took account of the complex nature of the survey (i.e., multiple stages, cluster, and stratification).

All statistical analyses were performed using the software package STATA v15.1 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX, USA).

## Results

Table 2 shows that 150,651 children were eligible for inclusion in the analysis out of >198,000 invited to participate from the 25 countries. The number of children included varied between countries, from <1,000 in Denmark, Ireland, and San Marino to >10,000 in Estonia, Italy, Spain, and Turkey. These substantial differences between countries were due to differences in the number of

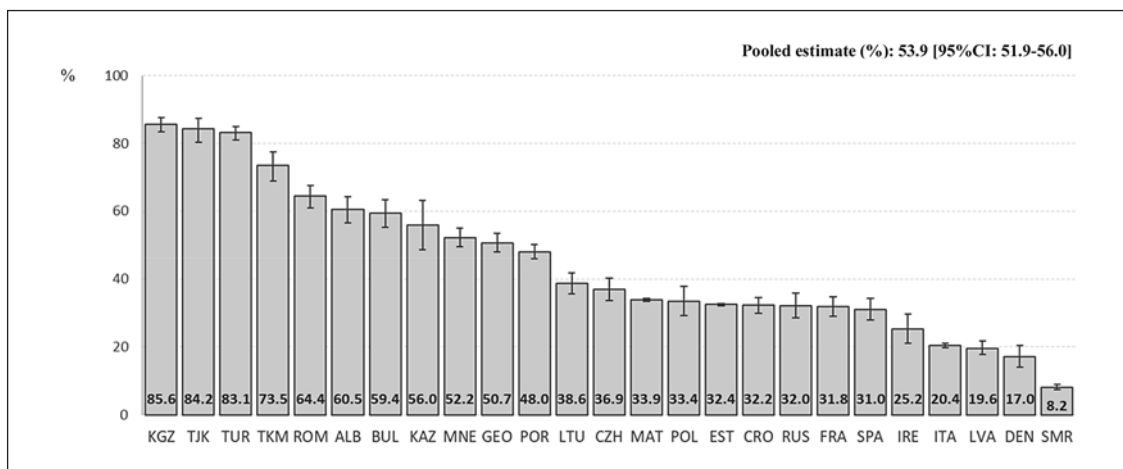
age groups that each country targeted, the characteristics of the national school system, and a country's willingness to produce estimates at sub-national levels. There were also considerable differences between countries in the proportion of children whose parents completed the questionnaires. Turkmenistan, Italy, Tajikistan, and San Marino had the highest family participation rate (approx. 95%), while Denmark and Ireland had the lowest (30 and 32%, respectively).

### Active Play

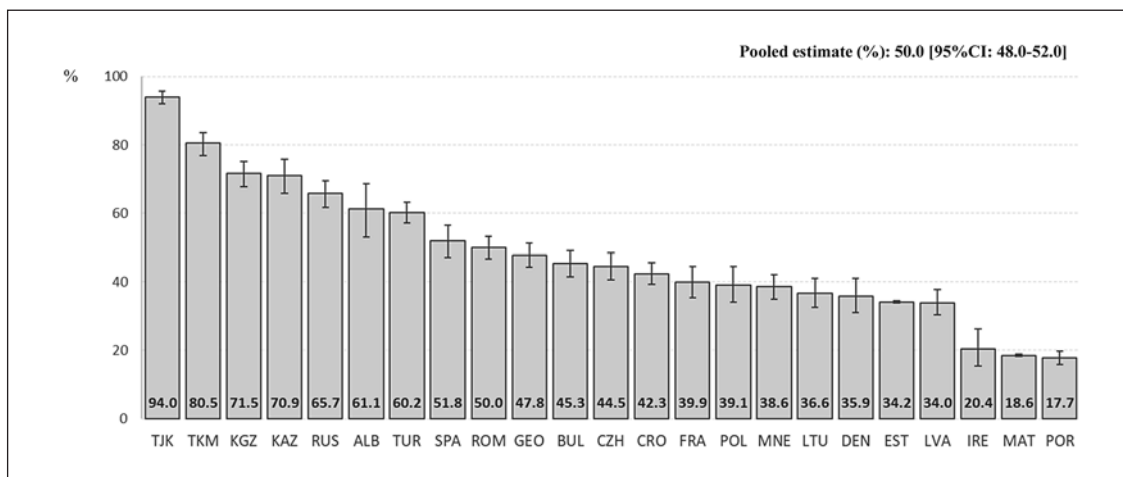
On average, around 4 in 5 children spent at least 1 h/day in active play. This figure varied between countries. While almost all children in Montenegro and Czechia spent at least 1 h/day actively playing, the corresponding figure was <2 out of 3 in Malta and Tajikistan (Fig. 1). In 5 countries, at least 60% spent >2 h/day in active play, namely, Czechia, Kyrgyzstan, Lithuania, Montenegro, and Romania. At the other end of the scale, lower proportions were registered in Denmark, Kazakhstan, Malta, Poland, Spain, and Tajikistan, (approx. ≤25%). Pooled and country-specific distributions of children by time dedicated to active play are presented in online supplementary Table 1.

### Sport Participation

On average, 53.9% children were not a member of a sport or dancing club, and 30.2% spent 1–3 h and 15.9% spent ≥4 h per week practising sports. At the country level, these figures varied greatly. In Denmark, Latvia, Italy, and San Marino, at least 80% of children were members



**Fig. 2.** Pooled and country-specific estimates (along with their 95% confidence intervals) of the percentage of children who were not members of sports/dancing clubs or did not do sports or dance at all (COSI/WHO Europe round 4 2015–17).



**Fig. 3.** Pooled and country-specific estimates (along with their 95% confidence intervals) of the percentage of children who used active transport (walking or cycling) to get to and from school (COSI/WHO Europe round 4 2015–17).

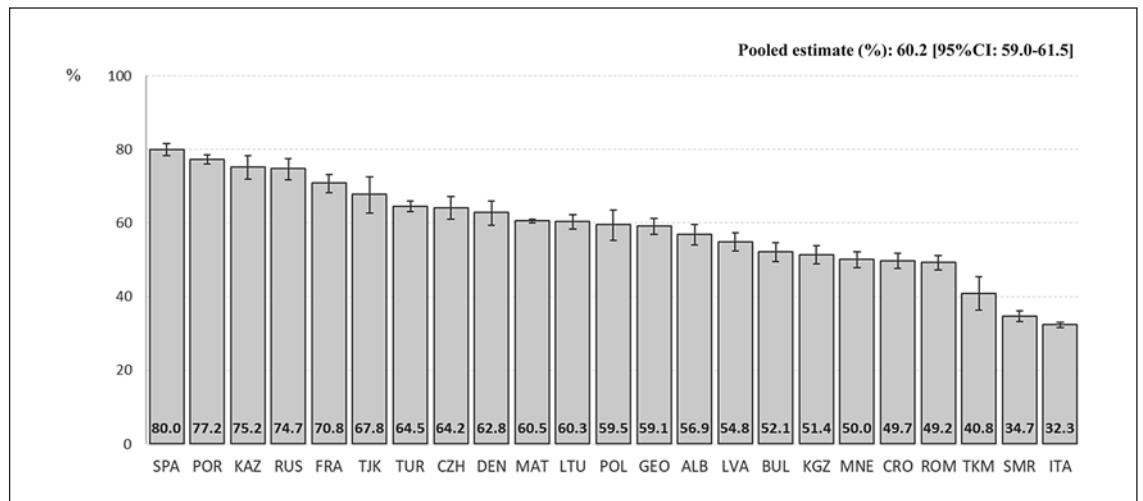
of a sport or dancing club whereas in Kyrgyzstan, Tajikistan, Turkmenistan, and Turkey, most were not (>80%) (Fig. 2). These latter countries also recorded the lowest proportions of children practising sports for  $\geq 4$ /week (<10%) whereas Latvia showed the highest value (41.1%), followed by the Moscow area (36.1%), and Croatia (33.4%). More than 4 in 10 children practised 1–3 h/week in 6 countries, namely, Denmark, Estonia, Spain, Czechia, Malta, and Poland; all other countries showed lower proportions. Pooled and country-specific distributions of

children by the time they dedicated to practising sports or dancing are presented in online Supplementary Table 2.

#### Active Transport

On average, 1 in 2 children used active means/transport, i.e., they walked or cycled, to get to and from school (50.0%), and 1 in 10 used a combination of active transport and motorised vehicles. However, there were substantial differences between countries. The proportion of children using active transport ranged from most of the children in Tajiki-





**Fig. 4.** Pooled and country-specific estimates (along with their 95% confidence intervals) of the percentage of children with <2 h of screen time per day (COSI/WHO Europe round 4 2015–17).

stan (94.0%) to only around 20% in Portugal, Malta, and Ireland (Fig. 3); in these 3 countries, most children (>70%) travelled to school by motorised vehicle, but in Tajikistan, very few did (approx. 3%). In the other central Asian countries, the proportion of children travelling by active transport to school was also high (80.5% in Turkmenistan, 71.5% in Kyrgyzstan, and 70.9% in Kazakhstan). In Croatia, Estonia, and Montenegro, around 1 in 4 children travelled to school by a combination of active transport and motorised vehicles. Pooled and country-specific distributions of children by transportation to and from school are presented in online supplementary Table 3.

#### Screen Time

On average, 60.2% of children were reported to be engaged in screen time for <2 h, 25.2% for 2–3 h, and 14.6% for ≥3 h per day, respectively. These figures varied greatly between countries. The proportion less engaged in screen time (i.e. for <2 h/day) ranged from 32.3% in Italy to 80.0% in Spain (Fig. 4). Between around one-quarter (26.5%) and more than half (58.9%) of children had approximately 1 h/day of screen time and between 16.8 and 41.6% of children spent around 2 h/day at a screen. Pooled and country-specific distributions of children by screen time are presented in online supplementary Table 4.

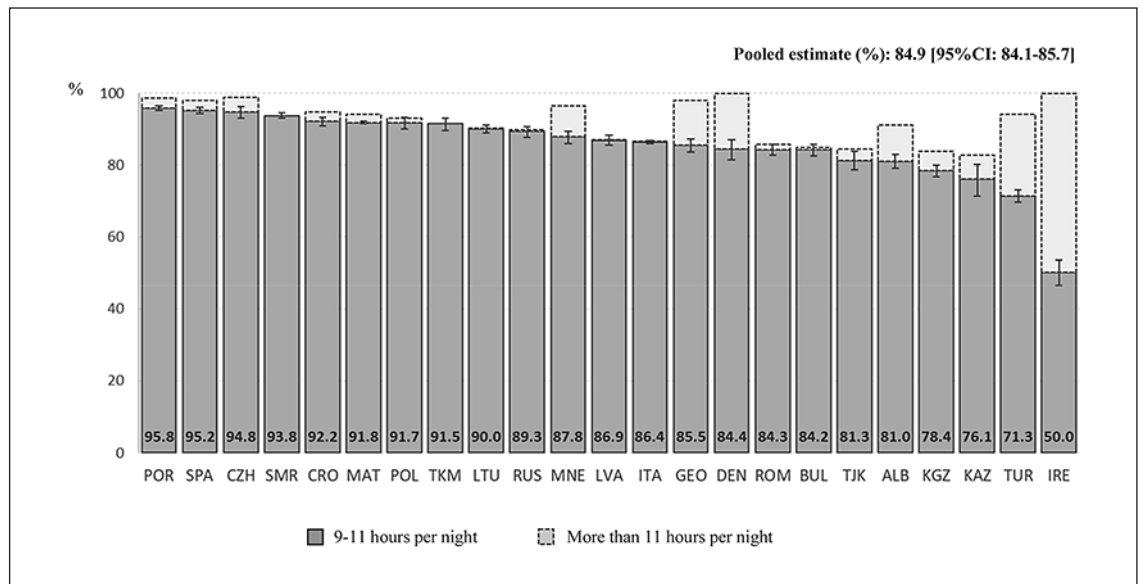
#### Sleep Duration

On average, 84.9% of children slept for 9–11 h/night, with heterogeneity among countries. The lowest propor-

tion was recorded in Ireland where half of children met the recommended number of hours of sleep per night whilst the other half slept >11 h (Fig. 5). In Portugal and Spain, >95% of children slept for 9–11 h. On average, around 5% of children slept for <9 h, with country-specific values ranging from virtually none in Denmark and Ireland to >15% in Bulgaria, Kazakhstan, Kyrgyzstan, and Tajikistan. Pooled and country-specific distributions of children by sleep duration are presented in online supplementary Table 5.

#### Differences by Sex

Girls compared to boys were slightly less engaged in active play in 10 countries, with >5 percentage points of difference recorded between girls and boys in San Marino, Spain, and Turkey. In most of the countries, girls were less engaged in practising sports than boys. On average, a higher proportion of girls were not members of a sport or dancing club than boys (56.3 vs. 51.8%), and a lower proportion (11.8%) spent ≥4/week practising compared to boys (19.7%). Pooled estimates and country-specific data showed no major differences in the proportions of girls and boys walking or cycling to school. In most countries, a higher proportion of boys than girls watched TV or used electronic devices for >3 h/day. Pooled estimates did not show a statistically significant difference in sleep duration between boys and girls.



**Fig. 5.** Pooled and country-specific estimates (along with their 95% confidence intervals) of the percentage of children who slept for 9–11 h per night (COSI/WHO Europe round 4 2015–17).

## Discussion

This study describes the prevalence of PA behaviours, screen time, and sleep duration among children aged 6–9 years from 25 countries in the WHO European Region. Comparable, nationally representative data showed pronounced differences in prevalence estimates for the various behaviours between the countries included. According to an ecological model [29], the differences observed could arise from a multitude of factors, including the policy, social, built and cultural environment, setting-specific characteristics, or differences in the natural environment.

Our results show that most children across the region engaged in active play for at least 60 min/day. There were variations across the countries included, which has been noted previously [30]. While active play is likely to be predominantly made up of light-intensity PA, for children in this age range active play can contribute substantially to total PA levels while reducing SB [31]. It is likely that opportunities for children to engage in active play depend on the physical environment, such as access to local parks and a recreational infrastructure [32]. The variation between the countries included in our study may also be influenced by differences in the relationship between the length of the day (the number of hours of daylight) and the weather conditions with PA levels, shown to differ between settings [33]. Different cultural values toward ac-

tive play and SB may explain some variations, both between countries and for boys versus girls; it may influence determinants for PA and SB, such as parental support [34]. The lower levels of active play among girls compared to boys in certain countries could also be explained by differing socioecological influences at the levels of the family, school, and environment [35]. The effect of the social environment on PA for boys and girls in playgrounds, for example, has also been shown to contribute to these gender differences in relation to active play [36].

Depending on the national context, sports organisations may function as an essential facilitator for PA and sport participation among children. Across the region, we found that around half of both boys and girls were members of a sport or dancing club; this was lower than the prevalence of sport participation found in similar studies [30, 37]. However, the COSI questionnaire asks specifically about membership of a sports or dancing club rather than participation, and this could explain why the prevalence we recorded was lower than in other studies that also captured informal sports participation (especially in Eastern Europe and Central Asia where formal grassroots sports organisations are less common). The proportion of girls participating in sport for  $\geq 4$  h/week was generally around half that of boys; this may be due to a lack of a variety of activities to better suit the preferences of girls [38].

Active transport to school can produce important health benefits [39]. There was substantial variation between countries in the prevalence of children actively travelling to school, which aligns with previous findings [30]. In the countries of Central Asia, where active transport may be a necessity, it was shown that >3 out of 4 children walked or cycled to school; in Portugal and Malta, where travelling to school by car may be more of a cultural norm, this proportion was <1 out of 5. This has also been noted previously [30]. Other factors influencing whether children walk, cycle, use public transport, or are driven to school by car are: the length of the school day and timetable, the availability of safe walking or cycling paths, access to free public transport, the location of elementary schools within communities, road safety, and weather conditions [32].

It is recommended that children in this age group spend <2 h/day engaging in recreational screen to avoid negative health outcomes [19–21]. Across the region, we found that more than half the children met this recommendation, which was much higher than recorded by previous studies that used self-reporting [40] and objective methods [41] to estimate screen time. It has been noted previously that parents underestimate screen time compared to children's self-reports [42], as they may be unaware of how much their children are using screen-based devices throughout the entire day. As with the other behaviours measured in our study, the differences between countries may have been due to variations in social/cultural and physical environments which are important in determining SB among children [43]. Across the region, longer screen time per day was more prevalent among boys than girls, in line with previous findings [44].

Sleep plays a vital role in health. It is recommended that children aged 6–9 years sleep for 9–11 h/night [19–21], and short sleep duration can be detrimental to physical and mental health and well-being [45]. We found that, across the region, most children achieved the recommended 9–11 h of sleep, a much higher proportion than found in other studies that used objective measurements to estimate sleep duration [40]. There were substantial differences between countries, which aligns with previous findings where children in more northerly countries generally slept the longest, likely due to different cultural and environmental characteristics [46]. For some of the countries that did not meet the recommendations, short sleep duration was not the issue; rather, the lower prevalence was due to the higher proportion of children recorded as sleeping for >11 h/night.

A key strength of this study is the use of systematic, nationally representative data collected via the COSI sys-

tem. In many of the countries included, these are the first-ever national estimates available of PA behaviours, screen time, and sleep duration of school-aged children. Another strength is the large sample size which increases confidence in the findings and limits the impact of outliers. There are, however, some limitations which must be mentioned. Due to the way the variables were operationalised, we were unable to calculate total PA according to WHO recommendations by combining active transport, active play, and sport participation. There may also be substantial discrepancies between the results of parent/caregiver reporting and other methods of measuring PA, screen time, and sleep, meaning that all results should be viewed with caution. Reporting of PA and SB might also have been vulnerable to differences in the terminology used across countries to describe these behaviours [47, 48]; the social desirability and attitudes related to higher PA levels and SB among children may also have varied across countries and influenced the responses. Finally, there is potential for selection bias, with the families that allowed their children to participate and were willing to complete the family form not necessarily representing those that did not give their consent.

## Conclusion

An analysis of the results of the WHO COSI 2015–2017 study provides a unique overview of the PA behaviours, screen time, and sleep duration of children aged 6–9 years in the WHO European Region. The heterogeneity in the prevalence between countries shows that there are opportunities for national policymakers to learn from experiences across the region and adopt what seems to be working. These results can help countries to prioritise actions to address specific PA behaviours that may be more effective in increasing overall PA levels and reducing SB. Local action is needed to address the lack of engagement in PA and the overuse of screen-based devices as well as to ensure the benefits of enough sleep. Further development of national procedures for monitoring these and other risk factors for NCDs are needed. Evaluations of existing prevention and management strategies targeting young people could be utilised to design and implement more effective interventions.

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## Statement of Ethics

The WHO COSI study protocol was approved by international ethics guidelines for biomedical research involving human subjects, and all procedures were also approved by local ethics committees in each country. Furthermore, the children's parents or guardians gave their written informed consent.

Ethics approval was provided by the following countries: Albania (Scientific Committee of Institute of Public Health, decision No. 953, 13/07/2015), Bulgaria (Commission of Medical Ethics at the National Center of Public Health and Analyses, Sofia, Bulgaria, Project identification code – 060 – MII 325 -68 COSI, 25.02.2016), Croatia (Ethics Committee of the Croatian Institute for Public Health, registry No. 80–2660/1–15, 25.9.2015), Czechia (Ethics Committee of the Institute of Endocrinology, Prague, Czech Republic, AZV MZČR 17–31670 A, 20/06/2016), Denmark (Research and Innovation Organization, SDU, 10.829, 27/06/2016), Estonia (Tallinn Medical Research Ethics Committee, TMEK decision No. 1376, 28/03/2016), Georgia (Bioethics Council at National Center for Disease Control and Public Health of Georgia, project identification code: 2019–52, 4 November, 2019), Ireland (University College Dublin Human Research Ethics Committee – Sciences, Project identification code: LS-15–43-Heinen-Kelleher, date of approval: 26 August 2015), Italy (National Institute of Health, Prot. PRE – 739/15, 10 November 2015), Kazakhstan (Scientific and technical program “Development and implementation of modern technologies for healthy lifestyle promotion and prevention of diseases based on the study of non-medical determinants of health among children,” 2015), Kyrgyzstan (The Ethics Committee on compliance of research to ethical norms for medical research, project identification code: No. 1/1, Date of approval: 22 February 2018), Latvia (Central Medical Ethics Committee, project identification code: 01–29.1/6, date of approval: 25.09.2015), Lithuania (Lithuanian Bioethics Committee (Lietuvos bioetikos komitetas); project identification code: 08–02–19; 19 February, 2008. After the approval we received renewal of a bioethics authorization in 2010 (on 2010–01–04), 2013 (on 2013–01–09) and 2019 (on 2019–03–12), Montenegro (Ethics Committee of the Institute of Public Health of Montenegro Project identification code: WHO 2016/627456–0, date of approval: 28th April 20), Poland (Bioethics Committee of the Institute of Mother and Child, Warsaw, Poland, project identification No. 22/2015, date of approval: 26 November 2015), Portugal (National Commission of Data Protection; Aut nº5418/2016 for all rounds of COSI Portugal, 7 June 2016), Romania (Intern Ethics Committee of the National Institute of Public

Health, Romania, project identification code: WHO 2016/650301–0, date of approval: 6 April 2016), Russian Federation (National Institute of Health., Prot. PRE – 739/15, November 2015 National Institute of Health, Prot. PRE – 739/15, November 2015), Tajikistan (Ministry of Health and Social Protection of Tajikistan, project identification code: #858, date of approval: 18 November 2016), Turkey (Kecioren Training and Research Hospital, Clinical Researches Ethics Committee; approval date: 26.10.2016, project identification code: Health System Strengthening and Support Project, LN: 8531-TR, date of approval 2015: L.2.12. Obesity Fighting Project, subcomponent 1.1, L.2.11). In Turkmenistan, ethics approval was granted from the Ministry of Healthcare and Medical Industry (MOHMI). Malta did not go through an ethics committee as all the work involved in COSI data collection and analysis is part and parcel of the existing School Health Service, which is an ongoing process. Data for COSI in Spain was collected as part of the ALADINO Spanish study, which did not ask for an ethics committee approval, since this is not mandatory in Spain. However, the principal investigators confirm that the study was conducted in accordance with the Declaration of Helsinki and all parents/guardians of subjects participating in the 4 rounds gave their informed consent for inclusion before they participated in the study.

## Conflict of Interest Statement

The authors declare no conflicts of interest. The funders had no role in the design of the study, collection, analyses, or interpretation of data, writing of the manuscript, or the decision to publish the results.

The writing group takes sole responsibility for the content of this article, and the content of this article reflects the views of the authors only. S.W, I.R. J.B. and J.W. are staff members of the WHO and M.B. and R.M. are WHO consultants. The WHO is not liable for any use that may be made of the information contained herein.

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## Author Contributions

S.W., M.B. and J.B. conceptualized the manuscript. S.W., M.B., M.P., K.A.O., and P.G. drafted the manuscript. M.B. conducted all analyses. J.B. made substantial contribution to drafts of both the manuscript and the COSI study protocol as well as interpretation of the results. J.H., V.D., S.M.M., H.Z., T.H., E.N., L.S., C.C.K., M.H., A.S., P.N., A.A., S.A., G.A., Z.U., I.P., A.P., V.F.S., E.K., S.P., A.F., A.R., M.A.C., L.A.B., V.P., A.G., M.G.S., E.G.G., Z.A., N.Y. and M.T. commented on drafts of the paper and contributed with data collection and data cleaning. D.W., K.S., D.S., A.F.H., E.M.I., M.H., V.A.K., S.O., L.T., G.S., K.R.J., I.S., J.W., I.R., R.M., H.R., A.S.F., I.H.B., M.R. and W.A. contributed to drafts of the manuscript. All authors contributed to and approved the paper.

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