Urban and rural differences in frequency of fruit, vegetable, and soft drink consumption among 6-9-year-old children from 20 countries from the WHO European Region

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Statement of ethics

The WHO COSI study protocol was approved by the International Ethical 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 caretakers have given their informed consent.

Potential conflicts of interest:

The authors declare no conflicts of interest.

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Abbreviations:

BMI, CI, COSI, OR, SES, WHO

Abstract

In order to address the paucity of evidence on the association between eating habits and urban or rural dwelling in childhood, this cross-sectional study describes urban-rural differences in frequency of fruit, vegetable and soft drink consumption in 123,100 children aged 6-9 years from 19 countries participating in round four (2015–2017) of the WHO European Childhood Obesity Surveillance Initiative. Children's parents/caregivers completed food frequency questions. We reported results stratified by country and region. A multivariate multilevel logistic regression analysis was performed. All indicators showed wide variability among countries and within macro-regions. The percentage of children attending rural schools ranged from 3% in Turkey to 70% in Turkmenistan. Further, 30%-80% and 30%-90% children did not consume fruit or vegetables daily, respectively, and ≤45% consumed soft drinks >3 days a week. For <one third of the countries, children attending schools in rural areas had higher odds (OR range: 1.1-2.1) for not eating fruit or vegetables daily or consuming soft drinks >3 days a week compared to children attending urban schools. For the remainder of the countries no significant associations were observed. Both population-based interventions and policy strategies are necessary to improve access to healthy foods and increase healthy eating behaviors amongst children.

Introduction

Childhood obesity is a major public health challenge.[1] According to the latest round of the WHO European Childhood Obesity Surveillance Initiative (COSI) conducted in 2015-2017, 41% and 36% of boys and girls, respectively, aged 7-9 years old had overweight or obesity (latest COSI report). These overall figures hide a great variability among countries. The overweight prevalence ranged from 9% to 43% in boys and from 5% to 43% in girls, whereas the obesity prevalence varied from 2% to 22% and from 1% to 19%, respectively. Obesity is caused by multiple factors, with unhealthy diets - characterized by a high consumption of fat- and sugar-rich foods, - and low levels of physical activity the main drivers of the high global prevalence and rising trends in childhood overweight and obesity.[2] Dietary habits established during childhood and adolescence tend to persist into adulthood.[3,4] Therefore, acquiring healthy dietary habits at early ages is crucial to prevent the development of obesity and other chronic diseases during both childhood and at later ages. A healthy diet includes the consumption of high amounts of fruits, vegetables, legumes, whole grains, and nuts, together with limited consumption of total saturated fat and sugars.[5] Information on children's eating habits and how they are distributed across different populations is crucial to develop effective obesity prevention strategies. In the past decades, researchers have made huge efforts to study modifiable factors associated with excess body weight in young populations.

The association between socio-economic status (SES) and diet quality is well documented in the literature. Both adults and children with higher SES have healthier diets than those with lower SES.[6-9] On the contrary, evidence available on the difference between eating habits in urban and rural dwellings in school-aged children is still scarce and inconsistent. A narrative review on the diet in rural vs urban children and adolescents in the United States only found five studies that investigated this topic.[10] Among these, two studies did not observe differences between rural and urban children[11,12] and two studies reported rural children eating fewer vegetables[13] and fruit and more dairy.[14] On the other hand, Australian pre-school children from rural areas had healthier weight-related behaviors than their peers from urban areas.[8] Studies conducted in Europe have also reported

inconclusive findings. While Colić-Barić et al.[15] have observed that energy and nutrient intakes were more adequate among urban than rural 12-year-old Croatian children, another study conducted in a sample of Croatian adolescents aged 12-17 years did not observe differences in total daily energy intake and other nutritional characteristics, except for fat intake.[16] In addition, those from rural areas consumed significantly less fast food and more fruits than those from urban areas [16]. Similarly, Lazarou & Kalavana[17] found that Cypriot children aged 9-13 years from rural areas consumed more traditional foods and were less likely to eat fast food. Finally, a study among Italian 8-year-olds did not observe any difference by urbanization level for fruit and vegetable consumption.[18] To the best of our knowledge, no previous studies have investigated rural vs urban differences in primary school-aged children's eating habits involving comparisons among countries. This study aims to investigate urban-rural differences in frequency of fresh fruit, vegetable, and soft drink consumption in a large sample of primary school-aged children aged 6 to 9 years from 19 European countries.

Methods

This study used data from round 4 of the WHO European Childhood Obesity Surveillance Initiative (COSI) conducted in 2015-2017. The COSI study routinely estimates overweight and obesity prevalence of primary schoolchildren aged 6-to-9 years old.[19,20]

It allows countries to monitor the progress of the obesity epidemic in this population group and allows between-country comparisons within the WHO European Region to generate necessary knowledge to inform policy-makers to take action to reverse the trend.[21] In addition to the anthropometric examinations, data on simple indicators of energy balance-related behaviors, including dietary intake, physical activity, screen time use, and of household sociodemographic information including parental education and urbanization level, are collected through an optional family questionnaire.[19,20,22] (+ref Methodology paper suppl Obes Facts) This study focuses on data obtained in 19 of 23 countries that collected data on children's fresh fruit, vegetable and soft drink consumption: Albania, Bulgaria, Croatia, Denmark, Georgia, Ireland, Italy, Kazakhstan, Kyrgyzstan,

Latvia, Lithuania, Montenegro, Poland, Portugal, Romania, Spain, Tajikistan, Turkey and Turkmenistan. Malta, San Marino and the Russian Federation, where the data collection took place only in Moscow, were not included because all children lived in areas with the same level of urbanization. Data from Czechia were excluded because it was not possible to determine the level of urbanization of the schools attended by children in the study were located. Children were included in this study if they a) were 6-9 years old, b) had information on at least one of the investigated dietary habits (i.e., consumption of fresh fruit, vegetable and sugar-sweetened soft drinks), and c) had data on the level of urbanization of the location of the schools attended by the children.

The COSI study follows the International Ethical Guidelines for Biomedical Research Involving Human Subjects.[23] The study was approved by local ethical committees in each country. Parents were fully informed about the study procedures. In some countries, parents had to provide written signed consent to allow their children to participate in the study (active consent approach), whereas other countries adopted a passive informed consent approach. Regardless of the consent approach, children verbally agreed to participate in the study on the measurement day. More details on data collection procedures can be found elsewhere.[19,20,22] (+ref Methodology paper suppl Obes Facts)

Sampling of children

Two-stage cluster sampling was used in most of the countries with school as primary sampling unit and school class as the secondary sampling unit to draw nationally representative samples of children. A cluster design with higher number of stages was adopted in Bulgaria (3 stages) and Poland (4 stages). Four countries adopted a cluster design with classes (Croatia and Italy) and schools (Denmark and Latvia) as sampling units. Bulgaria and Ireland followed a sentinel approach; the same schools measured in previous rounds were included and classes were randomly selected at each site. Lithuania followed a sentinel approach combined with the selection of new schools by region and by level of urbanization. Further details about the sampling characteristics have been described elsewhere.[20,22,24] All children registered in the sampled classes were invited to take part in the study and those who had parental consent received the family questionnaire. Paper and online versions of the family

questionnaire were available for completion. Each country selected the approach that was most convenient for them.

Measurements

Urbanization level of children's residence place and of the place where the school was located

The categorization of the 'urbanization level' of the child's place of residence was collected through the child's record form: the examiner, together with school staff (school principal, teacher or administrative staff), registered this information as "urban", "semi-urban" or "rural". The definition of these three categories was established at country level (see Table 1). Seven countries collected the urbanization level of the place where the school was located as a "proxy" of the urbanization level of children's place of residence. In order to increase the comparability among countries, the urbanization level of the place where the school was located was used in the statistical analysis instead of the urbanization level of the children's residence place. For the purposes of this study, a school was defined as 'rural' if at least 55% of the children from that school were residents of rural areas. Similarly, if at least 55% of children lived in "urban" or "semi-urban" areas the school was defined as an 'urban' school. These percentages were calculated including all children with the child's record form filled out, regardless if the information about the urbanization level of child's place of residence was available or not. Those schools that did not meet any of the two above-mentioned definitions because of the high level of missing data or because of the equal distribution of children among rural and urban areas, were excluded from the analysis. In most of the schools, the percentage of children living in areas with the same urbanization level was much greater than the threshold of 55% (between 80 and 100%), so the amount of children resident in places with an urbanization level different from the one of the school location was limited (Table 1). The percentage of "misclassified" children is below 5% in all countries but in Denmark (9.5%) and Lithuania (6.4%), suggesting that children in the age groups targeted by COSI mainly attended schools near their house. For the purposes of this study, "urban" and semi-urban" categories were combined.

Eating habits

Frequency of fruit, vegetable (excluding potatoes), and soft drink consumption during a normal week were reported by parents through food frequency questions included in the family questionnaire. These food groups were selected based on the WHO recommendations to keep a healthy diet.[25] Responses included four frequency categories of consumption: 'never or <once a week', 'some days (1–3 days)', 'most days (4–6 days)', 'every day'. The answers were dichotomized as 'healthy' and 'less healthy'. The 'less healthy' behaviors were: not eating fresh fruit every day, not eating vegetables every day, and consuming sugared soft drinks more than three days per week.[24]

Parental educational attainment

The socioeconomic status of families was assessed through the parents' educational attainment which was categorized as follows: 1) Low parental education level (both parents with lower education); 2) Medium parental education level (one parent with lower education, one parent with higher education); 3) High parental education level (both parents with higher education). Lower education level was defined by grouping together the following answer options: 'primary school or less', 'secondary or high school' and 'vocational school'. Higher education level includes 'undergraduate or bachelor's degree' and 'master's degree or higher'. The COSI family form asked about the education of the respondent's and his/her partner/spouse, so the information about parents' education was available only when the form was filled in by the mother or the father. In Bulgaria, Italy, Spain and Turkey, the education and employment of the parents was gathered instead.

Statistical analysis

For each country, we estimated the distribution of children by sex, age, and urbanization level of the place where the school that the children attended was located. The country-specific percentages of having a 'less healthy' behavior were estimated for fresh fruit, vegetable, and soft drink consumption by the urbanization level of the school location. A design-adjusted version of the Pearson's $\chi 2$ test, the Rao-Scott method, was used to determine the statistical significance of differences in the percentages among children that attended urban or rural schools.

For each dietary behavior, we estimated a country-specific multivariate multilevel logistic regression model to examine the association between having a 'less healthy' behavior (compared to not having it) and the level of urbanization of the school location. The odds ratio (OR) for attending a rural school versus an urban school was estimated along with its 95% confidence interval (CI) by adjusting for children's sex and age, parental education, and the region/administrative division where the child lived. Further adjustment for nutritional status (overweight/obesity) did not change the models, hence it was decided not to include it in the final models. As the urbanization variable is a school-level variable and not a child-level variable, school was included as a random effect in all regression models. Due to the limited number of observations, regression analyses were not carried out for Ireland regarding soft drinks.

We applied sampling weights for all countries to adjust for the sampling design, oversampling and parents' or children's nonresponse, except for Lithuania where the analysis was unweighted. A p-value of 0.05 was used to define statistical significance. All statistical analyses were performed in the statistical software package Stata version 15.1 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

Results are presented in the tables by grouping countries in 5 macro-regions according to United Nations "Standard Country or Area Codes for Statistical Use":[26] Northern Europe (Denmark, Ireland, Lithuania and Latvia); Eastern Europe (Bulgaria, Poland and Romania); Southern Europe (Albania, Croatia, Italy, Montenegro, Portugal and Spain); Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan) and Western Asia (Georgia and Turkey).

Results

A total of 123,100 children from 19 countries were included in the analysis. The number of children participating per country varied widely, from 873 children in Ireland to 43,484 children in Italy (Table 2). The mean age of the children was 7 or 8 years of age and approximately 50% were boys (Table 3). The percentage of children attending schools located in rural areas ranged from 3% in Turkey to

70% in Turkmenistan (Table 3). In most of the countries, children attending schools located in rural areas was less than one quarter, except for the countries in the Central Asia macro region where >50% of children attended schools in rural areas.

Differences in percentage between children attending schools located in rural vs urban areas

Fresh fruit

The percentages of children not eating fresh fruit daily varied widely among countries; from 29% and 27% in Italy for rural areas and urban areas, respectively to 85% in Kyrgyzstan and 82% in Lithuania (Table 4). This same wide variation was seen within the macro-regions. For the majority of countries, the percentage of children not eating fresh fruit daily did not differ between rural vs urban areas. No differences were found for any of the countries in the Northern European region. For the other regions, some statistically significant differences were found. Bulgaria in the Eastern European region showed a statistically significant higher percentage of children not eating fruit daily in rural vs urban areas. The same was observed for Albania, Italy and Montenegro in Southern Europe, Kazakhstan and Kyrgyzstan in Central Asia, and Turkey in Western Asia, all observing statistically significant higher percentages of not eating fruit daily in rural areas vs urban areas

Vegetables

The percentages of children not eating vegetables daily again varied widely among countries and was higher than for not eating fresh fruit daily for all countries except Kyrgyzstan and Tajikistan from the Central Asian region. The percentages varied from 33% and 31% in Turkmenistan for rural and urban areas, respectively to 92% and 91% in Spain (Table 4). This same variation was seen within the macro-regions. For two thirds of the countries, the percentage of children not eating vegetables daily did not differ between rural vs urban areas. No differences were found for any of the countries in the Northern European and Central Asian region. For the other regions, some statistically significant differences were found. Bulgaria and Poland in the Eastern European region both showed a statistically significant higher percentage of children not eating vegetables daily in rural vs urban areas. The same was observed for Montenegro and Portugal in Southern Europe, and Turkey in

Western Asia, all observing statistically significant higher percentages of not eating vegetables daily in rural areas vs urban areas.

Soft drinks

The percentages of children consuming soft drinks more than 3 days a week varied from <2% in Ireland for rural and urban areas to 44% in Croatia and Tajikistan for rural areas and 45% in Tajikistan and Turkmenistan for urban areas (Table 4). As for fruit and vegetables, this same variation between countries was seen within the macro-regions. For about half of the countries, the percentage of children consuming soft drinks more than 3 days a week did not differ between rural vs urban areas. No differences were found for any of the countries in the Central Asian region. For the other regions, some statistically significant differences were found, with all but one showing a higher percentage of children consuming soft drinks more than 3 days a week in rural areas vs urban areas: Denmark in Northern Europe, all countries in Eastern Europe (Bulgaria, Poland and Romania), Albania and Croatia in Southern Europe, and Georgia in Western Asia. Only Portugal in Southern Europe showed a slightly lower but statistically significant percentage of children consuming soft drinks more than 3 days a week for rural vs urban areas (11% vs 15%, respectively; $p<0.05$).

Multivariate multilevel regression models on eating habits by level of urbanization

Figure 1 shows the results of the multivariate multilevel regression model investigating the association between having a less healthy eating habit (compared to not having it) related to the level of urbanization of the school location; random effects for schools were included in this analysis. Overall, results of the regression analysis were comparable to analysis on the differences in percentages. For fresh fruit, no significant associations were observed for included countries of Northern Europe, Central Asia and Western Asia. Only for Bulgaria in Eastern Europe, and Albania in Southern Europe, children attending schools located in rural areas had a statistically significantly higher odds ($OR\geq1.4$) for not eating fruit daily compared to children attending schools in urban areas. A statistically significant higher but small odds was observed for Italy ($OR<1.1$). For vegetables, no significant associations were observed for Northern Europe and Central Asia. For the rest, results

were slightly mixed with higher odds observed for children attending schools in rural areas and not eating vegetables daily for Bulgaria and Poland in Eastern Europe and Italy in Southern Europe. But statistically significant lower odds were observed for Romania in Eastern Europe and Turkey in Western Asia. For the remainder of the countries in these regions, no significant associations were observed. For soft drinks, no associations were observed for Western Asian countries and for several other countries from the other regions. For Denmark in Northern Europe, Bulgaria and Romania in Eastern Europe, Croatia in Southern Europe and Kazakhstan in Central Asia, statistically significant higher odds were observed for children attending rural schools and consuming soft drinks more than 3 days a week compared to children attending urban schools (OR>1.6). Only for Portugal a statistically significant lower odds was observed.

Discussion

This paper investigated whether there were urban and rural differences in eating habits in a large sample of 123,100 children living in 19 European countries that participated in the fourth round of COSI (2015-17). Overall, for the majority of countries included in the current analysis no difference was observed in fresh fruit, vegetable or soft drink consumption between children attending rural or urban schools and where differences were observed between rural and urban, the odds were slightly elevated or decreased. Only for Bulgaria in Eastern Europe and Albania and Italy in Southern Europe, children attending schools located in rural areas had a higher odds for not eating fruit daily compared to children attending schools in urban areas. For vegetable consumption, results were slightly mixed with two countries in Eastern Europe (Bulgaria and Poland) and one in Southern Europe (Italy) showing higher odds for not eating vegetables daily for children attending schools in rural area, whereas the other country included in this analysis from Eastern Europe (Romania) and Turkey in Western Asia observed lower odds for not eating vegetables daily. For soft drink, again, just a few studies have observed higher odds for children attending rural schools consuming more soft drinks compared to children attending urban schools. These were Denmark in Northern Europe, Bulgaria

and ROM in Eastern Europe, Croatia in Southern Europe and Kazakhstan in Central Asia. Whereas Portugal observed a lower odds for soft drink consumption. Another point that can be made for the results of this paper is that 30% to 80% primary school aged children did not consume fresh fruit daily, 30% to as high as 90% did not eat vegetables daily and up to 45% consumed soft drinks more than 3 days a week.

There are few studies that investigated urban and rural differences in eating habits in studies that included primary school-aged children[8,11-13,15-18] and half of these did not observe any differences by urbanization level for fruit, vegetable or soft drink consumption.[11,12,17,18] For fruit intake, results from the literature are mixed. One US study has observed a lower percentage among adolescents living in rural areas consuming the recommended amount of fruit compared to those living in urban areas,[13] but they did not observe this difference in the primary school-aged children. In contrast, a Croatian study among children and adolescents has observed a higher percentage of energy contributed to fruit intake in participants living in rural area versus urban areas.[16] And among preschoolers, 5-year olds living in rural areas were more likely to meet the fruit recommendation than urban children.[8] Finally, five other studies did not observe a difference for fruit intake by urbanization level.[11,12,15,17,18] For vegetables intake, most studies have observed no difference for intake by urbanization level.[8,12,13,16-18] Only one study amongst Croatian children and adolescents has observed that a higher percentage of daily energy came from vegetables amongst students living in rural areas versus students living in urban areas.[15] For soft drinks, again most studies showed no difference by urbanization level.[11-13,17] Only one Croatian study has observed children and adolescents living in urban areas significantly consuming a higher amount of soft drinks compared to students living in rural areas.[15] This was in contrast with the findings of the current study that showed Croatian children attending a school in rural areas having a higher odds of consuming soft drinks more frequently than children at urban schools. As all studies – but one[11] – did either not include or poorly adjusted for confounders in their analysis, comparing our results with these studies is difficult.

Globalization has led to urbanization as well as drastic changes to the food system (i.e., all processes and infrastructure involved in feeding a population, from farm to fork).[27] One of the consequences of this has been what is called the nutrition transition where traditional diets shifts to "Westernized" diets (i.e., diets high in refined food products, glycemic load, saturated fats, and salt, and low in fiber, and less nutrient-dense).[27] This transition happened at first in industrialized nations, but is momentarily occurring at an accelerated pace in low- and middle-income countries.[28] Further, within countries, these changes has affected urban areas at first, but more increasingly rural areas are affected too.[29] So, even though, people in rural areas might be more likely to grow their own food (e.g. vegetables) and have less fast food outlets available, studies show that residents of rural communities have less access to healthy food due to limited infrastructure, types of outlets, long distances to food outlets, and fewer healthy options.[30-32] Powell et al.[33] have observed that in the US all food store types and, in particular, chain supermarkets are significantly less available in rural areas. This was confirmed in another US study that showed that most stores in a rural country were convenience stores with more unhealthy foods and healthful foods being more expensive than the less healthful version.[34] A review on food access across small food stores found that small food stores in rural areas lacked healthy food options largely because storeowners perceived that their customers would not purchase healthier items.[35] So, it seems that rural and urban populations might have different challenges to access more healthful foods and hence, different strategies will be needed to address these.[31]

This study has a number of limitations. The food frequency questionnaire we used was designed as an easily applicable monitoring tool to obtain an overall indication of a child's usual consumption frequencies of a food group, but it has not been validated, and does not collect information on portion sizes. The cross-sectional design of this study does not allow us to make any causal inferences. The reliance on parental reports of children's diet behaviors may have limited accuracy and such reports are subject to measurement error, recall bias, selection bias and social desirability bias.[36] This may have led to some degree of differential misreporting, i.e., over-reporting of healthier behaviors and

under-reporting of those regarded as less healthy. Furthermore, for the current analysis, each country defined urban, semi-urban and rural areas using their own national definition. In our studies most studies used measures of population size and/or density (n=10), administrative decisions (n=4) or a combination of these (n=4) for their national definition. There is currently no internationally accepted definition of rurality,[37] and although using an internationally accepted definition might be more transparent and make intercountry comparisons easier, using national definitions might be an advantage as it is more relevant to a country as the national definition is linked with infrastructure and service provision, including a country's food system. Furthermore, another study showed that country definitions of urban seem to be similar to standardized UN definitions[38] and hence, might not have hugely impacted the results from our study. Finally, we used the urbanization level of the school location instead of the children's place of residence as the latter information was not available for all included countries. However, of the 10 studies that had information of the child's place of residence, misclassification was less than 5% for eight countries and less than 10% for the other two countries; hence our results will most probably not have been affected by using the school location. This as most primary schools tend to enroll children to their schools within a certain catchment area or distance to the school and hence, most children tend to live close to their school. The main strengths of this study include the very large sample size of more than 123,000 children from diverse geographical areas of Europe and Asia, using country-based sampling strategies designed to yield nationally representative samples and a common protocol for collecting data which allows intercountry comparisons. Furthermore, our study has information about relevant confounders that were included in the multivariate analysis. This is in contrast with all other studies – but one[11] - which were unadjusted or poorly adjusted.[8,12,13,15-18] Future studies should include relevant confounders when looking into differences in eating habits by urbanization level.

Conclusion

This large study has showed that children's frequency of fruits, vegetables and soft drinks did not differ between children attending schools located in rural areas versus urban areas across Europe and Central Asia. Furthermore, both in urban and rural areas, eating behaviors were not optimal and need improvement. Both population-based interventions and policy strategies are necessary to improve access to healthy foods and increase healthy eating behaviors amongst children, with different strategies maybe needed for urban and rural areas as the needs are different.

References

1. WHO. Childhood overweight and obesity 2020 [cited 2020 12 Oct]. Available from: https://www.who.int/dietphysicalactivity/childhood/en/.
2. WHO. What are the causes? [cited 2020. Available from: https://www.who.int/dietphysicalactivity/childhood_why/en/.
3. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J Nutr*. 2005;93(6):923-31.
4. Movassagh EZ, Baxter-Jones ADG, Kontulainen S, Whiting SJ, Vatanparast H. Tracking Dietary Patterns over 20 Years from Childhood through Adolescence into Young Adulthood: The Saskatchewan Pediatric Bone Mineral Accrual Study. *Nutrients*. 2017;9(9).
5. WHO. Children's diet 2020 [cited 2020 12 Oct]. Available from: https://www.who.int/dietphysicalactivity/childhood_diet/en/.
6. Crawford PB, Obarzanek E, Schreiber GB, et al. The effects of race, household income, and parental education on nutrient intakes of 9- and 10-year-old girls. NHLBI Growth and Health Study. *Ann Epidemiol*. 1995;5(5):360-8.
7. Drewnowski A, Specter SE. Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr*. 2004;79(1):6-16.
8. Hardy LL, Baur LA, Wen LM, Garnett SP, Mihrshahi S. Descriptive epidemiology of changes in weight and weight-related behaviours of Australian children aged 5 years: two population-based cross-sectional studies in 2010 and 2015. *BMJ Open*. 2018;8(4):e019391.
9. Lioret S, Touvier M, Lafay L, Volatier JL, Maire B. Dietary and physical activity patterns in French children are related to overweight and socioeconomic status. *J Nutr*. 2008;138(1):101-7.
10. McCormack LA, Meendering J. Diet and Physical Activity in Rural vs Urban Children and Adolescents in the United States: A Narrative Review. *J Acad Nutr Diet*. 2016;116(3):467-80.
11. Davis AM, Bennett KJ, Befort C, Nollen N. Obesity and related health behaviors among urban and rural children in the United States: data from the National Health And Nutrition Examination Survey 2003-2004 and 2005-2006. *J Pediatr Psychol*. 2011;36(6):669-76.
12. Davis AM, Boles RE, James RL, et al. Health behaviors and weight status among urban and rural children. *Rural Remote Health*. 2008;8(2):810.
13. Liu JH, Jones SJ, Sun H, et al. Diet, physical activity, and sedentary behaviors as risk factors for childhood obesity: an urban and rural comparison. *Child Obes*. 2012;8(5):440-8.
14. Ettienne-Gittens R, McKyer EL, Odum M, et al. Rural versus urban Texas WIC participants' fruit and vegetable consumption. *Am J Health Behav*. 2013;37(1):130-40.

15. Colic-Baric I, Kajfez R, Satalic Z, Cvjetic S. Comparison of dietary habits in the urban and rural Croatian schoolchildren. *Eur J Nutr*. 2004;43(3):169-74.
16. Sila S, Pavic AM, Hojsak I, et al. Comparison of Obesity Prevalence and Dietary Intake in School-Aged Children Living in Rural and Urban Area of Croatia. *Prev Nutr Food Sci*. 2018;23(4):282-7.
17. Lazarou C, Kalavana T. Urbanization influences dietary habits of Cypriot children: the CYKIDS study. *Int J Public Health*. 2009;54(2):69-77.
18. Tognarelli M, Picciolli P, Vezzosi S, et al. Nutritional status of 8-year-old rural and urban Italian children: a study in Pistoia, Tuscany. *Int J Food Sci Nutr*. 2004;55(5):381-7.
19. Wijnhoven TM, van Raaij J, Breda J. WHO European Childhood Obesity Surveillance Initiative. Implementation of Round 1 (2007/2008) and Round 2 (2009/2010). Copenhagen, Denmark; 2014.
20. Wijnhoven TM, van Raaij JM, Spinelli A, et al. WHO European Childhood Obesity Surveillance Initiative 2008: weight, height and body mass index in 6-9-year-old children. *Pediatr Obes*. 2013;8(2):79-97.
21. Wijnhoven TM, van Raaij JM, Spinelli A, et al. WHO European Childhood Obesity Surveillance Initiative: body mass index and level of overweight among 6-9-year-old children from school year 2007/2008 to school year 2009/2010. *BMC Public Health*. 2014;14:806.
22. WHO European Childhood Obesity Surveillance Initiative. Overweight and Obesity among 6-to-9-Year-Old Children. Results of the Third Round of Data Collection 2012–2013. Copenhagen, Denmark; ; 2018.
23. Council for International Organizations of Medical Sciences/WHO. International Ethical Guidelines for Biomedical Research Involving Human Subjects. Geneva, Switzerland; ; 2002.
24. Williams J, Buoncristiano M, Nardone P, et al. A Snapshot of European Children's Eating Habits: Results from the Fourth Round of the WHO European Childhood Obesity Surveillance Initiative (COSI). *Nutrients*. 2020;12(8).
25. WHO. Healthy Diet: Key Facts 2020 [cited 2020 12 Oct]. Available from: https://www.who.int/news-room/fact-sheets/detail/healthy-diet#:~:text=A%20healthy%20diet%20includes%20the,cassava%20and%20other%20starchy%20roots.
26. United Nations Standard Country Code, Series M: Miscellaneous Statistical Papers, No. 49. New York: United Nations. ST/ESA/STAT/SER.M/49. .
27. Cordain L, Eaton SB, Sebastian A, et al. Origins and evolution of the Western diet: health implications for the 21st century. *Am J Clin Nutr*. 2005;81(2):341-54.

28. Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. *Nutr Rev*. 1997;55(2):31-43.
29. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev*. 2012;70(1):3-21.
30. Caspi CE, Sorensen G, Subramanian SV, Kawachi I. The local food environment and diet: a systematic review. *Health Place*. 2012;18(5):1172-87.
31. Johnson DB, Quinn E, Sitaker M, et al. Developing an agenda for research about policies to improve access to healthy foods in rural communities: a concept mapping study. *BMC Public Health*. 2014;14:592.
32. Walker RE, Keane CR, Burke JG. Disparities and access to healthy food in the United States: A review of food deserts literature. *Health Place*. 2010;16(5):876-84.
33. Powell LM, Slater S, Mirtcheva D, Bao Y, Chaloupka FJ. Food store availability and neighborhood characteristics in the United States. *Prev Med*. 2007;44(3):189-95.
34. Liese AD, Weis KE, Pluto D, Smith E, Lawson A. Food store types, availability, and cost of foods in a rural environment. *J Am Diet Assoc*. 2007;107(11):1916-23.
35. Pinard CA, Byker Shanks C, Harden SM, Yaroch AL. An integrative literature review of small food store research across urban and rural communities in the U.S. *Prev Med Rep*. 2016;3:324-32.
36. Burrows TL, Truby H, Morgan PJ, et al. A comparison and validation of child versus parent reporting of children's energy intake using food frequency questionnaires versus food records: who's an accurate reporter? *Clin Nutr*. 2013;32(4):613-8.
37. Larson NI. Nutritional problems in childhood and adolescence: a narrative review of identified disparities. *Nutr Res Rev*. 2020:1-31.
38. DeVylder JE, Kelleher I, Lalane M, et al. Association of Urbanicity With Psychosis in Low- and Middle-Income Countries. *JAMA Psychiatry*. 2018;75(7):678-86.

Table 1 - Definitions of urban, semi-urban and rural areas as defined by each country and percentage (%) of children misclassified for urbanization level of the school location. COSI/WHO Europe round 4 (2015-17)

Country	Definition of "urban", "semi-urban" and "rural" areas	Unit to which the urbanization level refers	Misclassified children[a] (%)
ALB	Based on administrative division which takes into account population density and infrastructure level.	Child's residence place	0.0
BUL	*Based on the Law on Administrative-territorial structure of the Republic of Bulgaria and the Unified Classifier of administrative-territorial and territorial units* **Urban areas**: areas with 3,500 or above inhabitants **Semi-urban areas**: not applied **Rural areas**: areas with less than 3,500 inhabitants		3.1
CRO	We defined levels of urbanization based on the following reference: Croatian Bureau of Statistics. Census of Population, Households and Dwellings in 2011. FAMILIES, BY TYPE AND NUMBER OF CHILDREN. Available from: http://www.dzs.hr/Hrv/censuses/census2011/results/htm/h02_01_05/H02_01_05_RH.html Levels of urbanization were categorized as urban, semiurban or rural, and were defined based on the school location.	School location	0.0
DEN	**Urban areas**: city or large city with >10,000 inhabitants **Semi-urban areas**: smaller city with ≥1,000 inhabitants or suburban city with ≤10,000 inhabitants **Rural areas**: village or countryside area with <1,000 inhabitants	Child's residence place	9.5
GEO	**Urban areas:** A "City" is defined as a territory where industrial capitals of the country, manufactured goods, socio-cultural centers are situated. The number of citizens might be >5000. A geographical place with a population <5000 population might be defined as a "City" if it is the center of the region. In Cities, there is no infrastructure that is related to agriculture. **Rural areas:** A "Village" is a place where <2000 people live, who are mostly involved in agriculture. A "Small town" is a place where a comparably small size of manufactured goods and socio-cultural centers are situated.	School location	1.3
IRE	**Urban area** is defined as having population clusters of 1,500 or more inhabitants **Rural area** refers to areas outside clusters of less than 1,500 inhabitants	School location	0.0
ITA	*The following levels of urbanization were used: i) less than 10,000 inhabitants, ii) from 10,001 to 100,000 inhabitants, iii) from 100,001 to 500,000 inhabitants and iv) more than 500,000 inhabitants. For the purpose of the paper, these categories were grouped as follows:* **Urban areas**: settlements with at least 10,000 inhabitants **Semi-urban areas**: not applied **Rural areas**: areas or settlements with less than 10,000 inhabitants	School location	0.0
KAZ	*Based on the administrative and territorial structure of the Republic of Kazakhstan* **Urban areas**: cities **Semi-urban areas**: settlements with at least 2,000 inhabitants **Rural areas**: settlements with less than 2,000 inhabitants	Child's residence place	0.1
KGZ	Based on the administrative and territorial structure under the Law of the Kyrgyz Republic:	Child's residence place	1.4

	Urban areas: a city/urban unit is an administrative-territorial unit in the form of city of republican, regional and district significance as well as an urban-type settlement in which the local community exercises local self-government in the manner outlines in the Constitution and Laws of the Kyrgyz Republic. **Rural areas:** Village/ rural unit is a settlement that has reached a certain level of provision of amenities with a population of at least 50 people of which those employed in agricultural production and their family members make up at least half of the population.		
LTU	Based on the number of inhabitants.	Child's residence place	6.4
LVA	*According to the administrative division of territories in the country, the following levels of urbanization were used: i) Riga – capital city; ii) other cities; iii) towns and iv) rural areas. For the purpose of the paper, these categories were grouped as follows:* **Urban areas**: capital city, other cities and towns **Semi-urban areas**: not applied **Rural areas**: rural areas	Child's residence place	2.1
MNE	Based on population size and density definition	School location	2.7
POL	**Urban areas**: big town (over 100,000 of inhabitants) **Semi-urban areas**: small town (up to 100,000 of inhabitants) **Rural areas**: rural areas or village	Child's residence place	4.2
POR	*Based on categorization used by the National Statistics Institute* **Urban areas**: areas with a population density greater than 500 inhabitants / km2 or that integrates localities with more than 5000 inhabitants **Semi-urban areas**: areas with population density greater than 100 inhabitants /km2 or that integrate localities with population between 2000 and 5000 residents. **Rural areas**: remaining areas.	Child's residence place	3.4
ROM	**Urban areas**: cities with at least 10,000 inhabitants **Semi-urban areas**: not applied **Rural areas**: areas or settlements with less than 10,000 inhabitants	Child's residence place	2.0
SPA	*The following levels of urbanization were used: i) less than 10,000 inhabitants, ii) from 10,001 to 100,000 inhabitants, iii) from 100,001 to 500,000 inhabitants and iv) more than 500,000 inhabitants. For the purpose of the paper, these categories were grouped as follows:* **Urban areas**: settlements with at least 10,000 inhabitants **Semi-urban areas**: not applied **Rural areas**: areas or settlements with less than 10,000 inhabitants	School location	0.0
TJK	*Based on the administrative division of the territories in the country.* **Urban areas**: cities and regional centers **Semi-urban areas**: not applied **Rural areas**: villages or rural areas	Child's residence place	0.8
TKM			1.0
TUR	Based on administrative considerations	School location	0.8

[a] Percentage of children living in areas with an urbanization level which was different from the one where the school was located

Table 2 – Number of children and schools included in the analysis by country. COSI/WHO Europe round 4 (2015-17)

	Children aged 6-9 years 9 whose parents or caregivers filled in the family form	Children included in the analysis [a]		Schools with children aged 6-9 whose parents or caregivers filled in the family form	Schools included in the analysis [b]
		Total	With data on children's sex, age, region of residence and parental education		
Northern Europe					
DEN	957	929	837	89	86
IRE	874	873	791	107	107
LTU	3,812	3,194	2,825	100	87
LVA	5,707	5,698	4,992	96	96
Eastern Europe					
BUL	3,400	3,347	3,142	199	196
POL	2,945	2,915	2,596	133	132
ROM	6,610	6,533	5,503	198	198
Southern Europe					
ALB	2,527	2,281	2,131	45	45
CRO	2,651	2,631	2,482	162	162
ITA	43,696	43,484	39,946	2,373	2,373
MNE	2,736	2,711	2,562	97	97
POR	6,391	6,147	5,173	230	224
SPA	10,453	10,452	9,407	164	164
Central Asia					
KAZ	4,311	4,130	3,340	141	141
KGZ	7,567	7,412	5,599	150	148
TJK	3,270	3,261	2,836	153	153
TKM	3,891	3,864	3,507	159	159
Western Asia					
GEO	3,246	3,193	2,820	242	242
TUR	10,502	10,045	9,720	578	576
Total	**125,546**	**123,100**	**110,209**	**5,416**	**5,386**

Country abbreviations: Albania (ALB); Bulgaria (BUL); Croatia (CRO); Denmark (DEN); Georgia (GEO); Ireland (IRE); Italy (ITA); Kazakhstan (KAZ); Kyrgyzstan (KGZ); Lithuania (LTU); Latvia (LVA); Montenegro (MNE); Poland (POL); Portugal (POR); Romania (ROM); Spain (SPA); Tajikistan (TJK); Turkmenistan (TKM) and Turkey (TUR).

[a] All children whose age is between six and nine years old, with available information on the frequency consumption of either fresh fruit, vegetable or soft drink consumption and on the urbanization level of the school location.

[b] Schools attended by children included in the analysis.

Table 3 – Percentages of boys, mean and standard deviation (SD) of children's age in years and percentage of children attending schools located in rural areas by country. COSI/WHO Europe round 4 (2015-17)

	Boys *(%)*	**Children's age in years** *Mean (SD)*	**Children attending schools in rural areas** *(%)*
Northern Europe			
DEN	53.0	7.2 (0.3)	14.7
IRE	52.7	7.1 (0.4)	22.6
LTU	51.1	7.8 (0.3)	14.0
LVA	48.3	8.3 (1.0)	14.0
Eastern Europe			
BUL	51.5	7.6 (0.2)	21.4
POL	50.1	8.4 (0.2)	22.9
ROM	49.2	8.5 (0.6)	44.0
Southern Europe			
ALB	52.4	8.5 (0.7)	20.1
CRO	50.9	8.5 (0.3)	11.4
ITA	51.5	8.8 (0.3)	27.5
MNE	52.6	7.4 (0.6)	20.1
POR	50.9	7.5 (0.6)	11.3
SPA	50.9	8.0 (1.1)	19.5
Central Asia			
KAZ	50.5	9.0 (0.5)	52.5
KGZ	50.8	7.9 (0.7)	65.1
TJK	51.7	7.4 (0.3)	69.9
TKM	49.9	7.7 (0.3)	56.6
Western Asia			
GEO	51.2	7.6 (0.4)	30.4
TUR	50.8	7.5 (0.4)	2.5

For an explanation of the country abbreviations, see Table 2.

Table 4 – Country-specific prevalence (%) of children with a "less healthy" behaviour related to fresh fruit, vegetables and soft drinks consumption by the urbanization level of the school location (rural or urban). COSI/WHO Europe round 4 (2015-17)

	Not eating fresh fruit every day (%)			Not eating vegetables every day (%)			Consuming soft drinks more than 3 days a week (%)		
	Rural areas	*Urban areas*	*Total*	*Rural areas*	*Urban areas*	*Total*	*Rural areas*	*Urban areas*	*Total*
Northern Europe									
DEN [e]	40.1	39.9	39.9	56.6	46.2	47.7	14.7	6.7	7.9
IRE	45.8	36.9	38.9	50.5	54.9	53.9	0.8	1.6	1.4
LTU	82.9	82.4	82.5	86.2	86.5	86.5	12.0	9.0	9.4
LVA	79.0	76.5	76.9	82.8	82.1	82.2	13.8	11.8	12.0
Eastern Europe									
BUL [b;d;f]	73.1	62.3	64.6	82.2	70.1	72.7	30.8	14.1	17.7
POL [c;e]	66.7	62.5	63.5	83.2	75.0	76.9	34.1	28.0	29.4
ROM [f]	60.0	56.3	57.9	71.4	74.3	73.1	21.5	8.1	13.9
Southern Europe									
ALB [b;e]	52.1	39.1	41.6	72.3	73.4	73.2	19.2	13.3	14.5
CRO [f]	70.7	65.7	66.2	84.7	83.0	83.2	44.1	27.5	29.4
ITA [a]	28.7	27.0	27.4	45.6	46.3	46.1	n.a.	n.a.	n.a.
MNE [a;c]	59.8	52.9	54.3	75.7	69.0	70.3	37.1	31.2	32.4
POR [c;e]	38.2	36.8	36.9	67.0	61.5	62.1	11.4	15.3	14.9
SPA	73.3	70.5	71.1	91.6	90.8	90.9	3.0	3.8	3.7
Central Asia									
KAZ [a]	72.5	60.5	66.7	70.0	69.5	69.8	23.5	21.5	22.5
KGZ [b]	84.9	76.8	82.1	68.5	70.2	69.1	29.3	26.0	28.2
TJK	68.2	62.4	66.5	56.3	58.2	56.9	44.1	44.8	44.3
TKM	31.3	28.1	29.9	32.6	30.9	31.9	40.9	44.9	42.6
Western Asia									
GEO [f]	74.9	76.9	76.3	84.2	86.2	85.6	31.6	21.9	24.9
TUR [a;c]	57.2	49.0	49.2	81.5	88.3	88.1	22.2	17.6	17.7

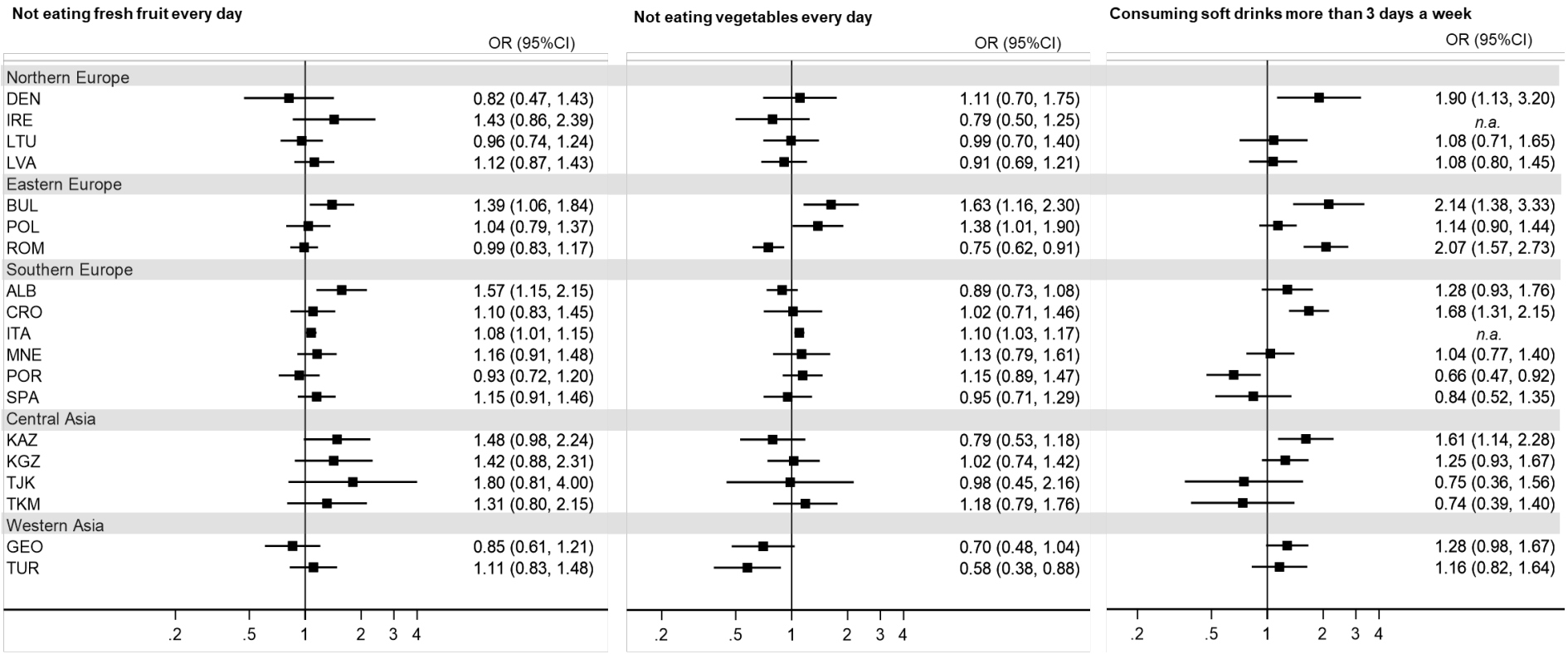
For an explanation of the country abbreviations, see Table 2. Abbreviation 'n.a.' means 'not available'.

[a, b] Statistically significant difference of percentages between children attending schools in urban areas and those attending schools in rural areas for not eating fresh fruit every day - Pearson's chi-squared corrected using Rao-Scott method, $p < 0.05$ (a), $p < 0.001$ (b).

[c, d] Statistically significant difference of percentages between children attending schools in urban areas and those attending schools in rural areas for not eating vegetables every day - Pearson's chi-squared corrected using Rao-Scott method, $p < 0.001$ (c), $p < 0.0001$ (d).

[e, f] Statistically significant difference of percentages between children attending schools in urban areas and those attending schools in rural areas for consuming soft drinks more than 3 days a week - Pearson's chi-squared corrected using Rao-Scott method, $p < 0.05$ (e), $p < 0.0001$ (f).

Figure 1 - Country-specific adjusted ORs of having a "less healthy" eating habit (compared to not having) related to the urbanization level of the school location (rural *vs.* urban areas)[a]. COSI/WHO Europe round 4 (2015-17)



For an explanation of the country abbreviations, see Table 2. Abbreviation 'n.a.' means 'not available'.

[a] Adjusted ORs and 95%CI were estimated through a multilevel logistic regression analysis with random effects for schools. The adjustment was carried out for children, sex, age, region of residence and parental education.