Time trends in consumption of sugar-sweetened beverages and related socioeconomic differences among adolescents in Eastern Europe: signs of a nutrition transition?

Angeline Chatelan,[1] Manon Rouche,[1] Anna Dzielska,[2] Thérésa Lebacq,[1] Anne-Siri Fismen,[3] Colette Kelly,[4] Apolinaras Zaborskis,[5] Jaroslava Kopcakova,[6] Anna Tsareva,[7] Michal Kalman,[8] and Katia Castetbon[1]

[1]School of Public Health, Université Libre de Bruxelles, Brussels, Belgium; [2]Department of Child and Adolescent Health, Institute of Mother and Child, Warsaw, Poland; [3]Department of Health Promotion, and Centre for Evaluation of Public Health Measures, Norwegian Institute of Public Health, Bergen, Norway; [4]School of Health Sciences, Health Promotion Research Centre, National University of Ireland Galway, Galway, Ireland; [5]Department of Preventive Medicine, Faculty of Public Health, Medical Academy, Lithuanian University of Health Sciences, Kaunas, Lithuania; [6]Department of Health Psychology and Research Methodology, Faculty of Medicine, P.J. Safarik University, Košice, Slovakia; [7]Division of Physical Rehabilitation and Health-Improving Technologies, Saint-Petersburg Scientific-Research Institute for Physical Culture, Saint-Petersburg, Russia; and [8]Department of Recreation and Leisure Studies, Faculty of Physical Culture, Palacky University Olomouc, Olomouc, Czechia

ABSTRACT

Background: High intake of sugar-sweetened beverages (SSBs) contributes to detrimental cardio-metabolic indicators in youth. Monitoring of SSB consumption is lacking in Eastern Europe.

Objectives: We assessed trends in the prevalence of adolescent daily consumption of SSBs in 14 Eastern European countries between 2002 and 2018, both overall and according to family material affluence.

Methods: We used 2002, 2006, 2010, 2014, and 2018 data of the Health Behaviour in School-Aged Children school-based study (repeated cross-sectional). Nationally representative samples of adolescents aged 11, 13, and 15 years were included ($n = 325{,}184$; 51.2% girls). Adolescents completed a standardized questionnaire, including a question on SSB consumption frequency. We categorized adolescents into 3 socioeconomic groups based on the relative Family Affluence Scale (FAS). Adjusted prevalences of daily SSB consumption by survey year, as well as country-level time trends between 2002 and 2018, were computed using multilevel logistic models (overall and by FAS groups).

Results: In 2018, the prevalence of adolescents consuming SSBs every day varied considerably between countries (range, 5.1%–28.1%). Between 2002 and 2018, the prevalence of daily SSB consumption declined in 10/14 countries (P for linear trends ≤ 0.004). The largest reductions were observed in Slovenia (OR, 0.48; 95% CI: 0.45–0.50) and the Russian Federation (OR, 0.67; 95% CI: 0.64–0.70). Daily SSB consumption was reduced at faster rates among the most affluent adolescents (who were larger consumers in 2002) than in the least affluent adolescents in 11/14 countries (P for linear trends ≤ 0.004). Thus, differences between FAS groups narrowed over time or even reversed, leading to larger proportions of daily consumers in the least affluent adolescents in 2018 in 5/14 countries ($P \leq 0.05$).

Conclusions: Adolescent daily consumption of SSBs decreased between 2002 and 2018 in most Eastern European countries. Declines were larger among higher-affluence adolescents. These results are useful to evaluate and plan interventions promoting healthy childhood diets. *Am J Clin Nutr* 2021;114:1476–1485.

Keywords: trend analysis, sugar-sweetened beverage, sodas, adolescents, Health Behaviour in School-Aged Children study, socioeconomic inequalities in diet, health equity, Eastern Europe, family affluence scale

Introduction

Sugar-sweetened beverages (SSBs) are a major source of added sugars among adolescents in Western (1) and Eastern (2) Europe and are contributors to dental caries (3) and excessive weight gain (4, 5). Worldwide, adolescents and young adults are the largest consumers of SSBs (6, 7). In US adolescents, the largest energy provider to SSBs was sodas (43%), followed by fruit drinks (17%), energy and sports drinks (11%), and other types of SSBs (29%) (7). Since the 2000s, adolescents in North America and Western Europe have reduced their consumption of SSBs, in particular of sodas (7–11). This may be related to the introduction of a combination of behavioral and structural public health interventions in these countries to improve diets in young people (12–14).

In Eastern Europe, data on adolescent SSB consumption are limited. A decrease in daily SSB consumption was observed in Czechia between 2002 and 2014 (15) and in Lithuania between 2002 and 2010 (16). As for trends in overall SSB sales in Eastern Europe after the 2010s, the literature is inconsistent: sales were on the rise according to Popkin and Hawkes (17) (results presented in kcal/capita) but on the decline according to Arsenault et al. (18) (results presented in mL/capita). Neither of these publications provided results at the country level, thus limiting the interpretation of these contradictory results

in Eastern Europe. In addition, sales statistics do not provide information about consumption in population subgroups, such as adolescents. Notwithstanding methodological challenges, these studies highlight the interest in analyzing temporal trends in SSB consumption in each country separately.

SSBs were among the first Western foodstuffs to be introduced into Eastern Europe in the post-Soviet period and are symbolic of the nutrition transition around the world (17, 19–21). The nutrition transition refers to changes in the population's dietary patterns resulting from economic and social development. For SSBs, a rise, sometimes followed by a decline, is expected in growing economies, as happened in Western countries (22, 23). These shifts usually occur first among groups with a higher socioeconomic position (SEP) (24–26). In most Western countries, socioeconomic inequalities in the adolescent diet are particularly pronounced for SSBs compared to other foods (27), with adolescents of lower SEP being higher consumers (10, 11, 28, 29). The situation may not be similar in Eastern European countries, depending on the stage of the nutrition transition (20, 30, 31). Information on changes in social patterning of large SSB consumption is valuable for public health stakeholders when evaluating and planning nutrition interventions. This paper aims to assess country-level trends in the prevalences of daily SSB consumption among adolescents from 14 Eastern European countries between 2002 and 2018, overall and according to family material affluence.

Methods

Design and populations

We used data from the 5 most recent survey years of the international Health Behaviour in School-Aged Children (HBSC) school-based study (http://www.hbsc.org): 2002, 2006, 2010, 2014, and 2018. This repeated cross-national survey has collected information on the health behaviors and well-being of adolescents aged 11, 13, and 15 years every 4 years since 1986 (32). In 2018, 47 countries or regions in Europe and Canada took part in the HBSC survey (33). Each national team recruited nationally representative samples, stratified by geo-political regions and/or school categories, and randomly selected classes by school. Adolescents filled out a standardized questionnaire in class after receiving instructions from teachers or research assistants (administration mode: paper or online) (33). More detailed information about the HBSC methodology can be found in Inchley et al. (33).

This paper includes information from 14 Eastern European countries with available data on SSB consumption since 2002 or 2006. To present results, we grouped countries into 3 geographical zones: Baltic ($n = 3$; Estonia, Latvia, Lithuania), Central ($n = 6$; Croatia, Czechia, Hungary, Poland, Slovakia, Slovenia) and Eastern ($n = 5$; Bulgaria, North Macedonia, Romania, Russian Federation, Ukraine). Participation rates were relatively high at the school and pupil levels (e.g., 2018 school rates: ≥78% in 12/14 countries; pupil rates: ≥80% in 10/14 countries) (32). The period of data collection varied according to country and survey year; however, 83% of participants were surveyed between February and May of each survey round.

Ethics

As required in the HBSC research protocol (33), authorizations from the institutional ethics committees or the relevant boards at the country level were obtained before proceeding with data collection. The surveyed schools, pupils, and their parents or guardians received detailed information about the study and were assured of their anonymity and the possibility to withdraw their participation. Pupils voluntarily filled out the anonymous questionnaire at school.

Daily SSB consumption

A 4-item validated FFQ assessed the consumption of SSBs (focusing mainly on sodas) together with fruit, vegetables, and sweets since 2002 (34). The general question was phrased as follows: "how many times a week do you usually eat or drink … ?" and the food list item analyzed in this study was: "Coke or other soft drinks that contain sugar" (33). National teams could add local examples of common brands in brackets to enhance question understanding. Daily consumers of SSBs were defined as those who ticked the response options "every day, more than once" or "once a day, every day." Other possible options were "5–6 days a week," "2–4 days a week," "once a week," "less than once a week," or "never" (33). According to the validation study, test-retest weighted kappa statistics for SSB consumption were acceptable (0.66 in 11- to 12-year-olds; 0.60 in 13- to 14-year-olds) and correlation with a 7-day food record was good [Spearman correlation coefficient: 0.46; mean consumption frequency (days/week): 4.23 in the FFQ compared with 4.07 in the food record] (34).

Socioeconomic position

The Family Affluence Scale (FAS) has been validated as a proxy measure of household material affluence for adolescents (35–37). The FAS was based on 4 (2002–2010) to 6 (2014–2018) wealth items: *1*) having one's own bedroom; *2*) number of cars in the family; *3*) number of computers/laptops/tablets in the

Health Behaviour in School-Aged Children (HBSC) is an international survey carried out in collaboration with the WHO Regional Office for Europe. Data collection is funded at the national level for each HBSC survey. The work related to this article was possible thanks to the academic support of the Université libre de Bruxelles, Belgium, and the financial support of the University of Lausanne, Switzerland (mobility fellowship). The work was also supported by the European Regional Development Fund-Project "Effective Use of Social Research Studies for Practice" (No. CZ.02.1.01/0.0/0.0/16_025/0007294) and by the Czech Ministry of Education, Youth and Sports, Inter-Excellence, LTT18020, as well as the Federal State Budgetary Institution "Saint-Petersburg Scientific-Research Institute for Physical Culture" in Russia. The funders had no role in the analysis, decision to publish, or preparation of the manuscript.

Supplemental Figures 1 and 2 and Supplemental Table 1 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/ajcn/.

Address correspondence to AC (e-mail: angeline.chatelan@ulb.be).

Abbreviations used: FAS, Family Affluence Scale; HBSC, Health Behaviour in School-Aged Children; SEP, socioeconomic position; SSB, sugar-sweetened beverage.

Received February 3, 2021. Accepted for publication May 4, 2021.

First published online June 4, 2021; doi: https://doi.org/10.1093/ajcn/nqab175.

family; *4*) number of vacation trips in the last year (rephrased as an abroad vacation since 2014); *5*) number of bathrooms in the house (since 2014); and *6*) having a dishwasher at home (since 2014) (35–37). FAS total scores (2002–2010, 0–9; 2014–2018, 0–13) were Ridit-transformed to rank adolescents from 0 (lowest SEP) to 1 (highest SEP) within each country, survey year, sex, and age category (11, 13, and 15 years). Ridit scores are based on cumulative probabilities, where the Ridit of the category i is the proportion (P) of all individuals below the category i plus half the proportion of individuals in the category i itself:

$$Ridit_i = \Sigma_{0 \leq k < i} P_k + 0.5 P_i \quad (1)$$

Based on the Ridit-based score, adolescents were categorized into 3 groups based on affluence: the lowest 20%, the medium 60%, and the highest 20%. This approach is recommended for trends analyses of cross-national HBSC data to estimate adolescents' relative SEP, ignoring variations in absolute material standards of living over time and across countries (38).

Statistics

Using STATA version 15 (Stata Corp.), we applied 2-level and 3-level multilevel logistic models with random intercepts (*melogit* and *xtmelogit*), setting daily SSB consumption as the dependent variable (0/1). Level 1 was set for the pupil, level 2 for the class (median cluster size: 17 pupils/class), and level 3 for the country (when several countries were analyzed together). We computed the prevalences of daily SSB consumers, adjusted for sex and age, by survey year for each country ($n = 14$), geographical zone ($n = 3$), and overall. We tested linear as well as 2-piecewise linear, quadratic, and cubic spline models to estimate the best fit between observed and predictive prevalences of daily SSB consumption (**Supplemental Figure 1**), expressing time as a continuous variable from 2002 to 2018 (scaled 1 to 5). Based on graphical output of the 4 models presented in Supplemental Figure 1, we then applied linear spline modelling and used 1 knot at the year 2006 (time = 2; command *mkspline*), composing 2 periods of analyses: the first analyzed period (2002–2006) and the second (2006–2018). We also investigated the overall linear trends between 2002 and 2018, disregarding potential short-term trends, which could be explained by slight differences in sample characteristics between survey years. Some seasonal variations in data collection across survey years were found in 9/14 countries. Therefore, time trends (but not prevalences) were also adjusted for months of data collection to account for potential seasonal effects, as nonalcoholic beverages are likely to be consumed in greater quantities in summer (39–41). To assess whether the most affluent 20% of adolescents (the reference group) reduced/increased their SSB consumption at a faster/slower rate over time than the least affluent 20%, we used multilevel logistic models (dependent variable: daily SSB consumption) adjusted for sex, age categories, survey years (5 dummies), and FAS categories (lower, medium, and higher affluence), with an interaction term between FAS categories and time (continuous). We then computed predictive margins to plot trends in the prevalences of daily SSB consumers by FAS categories. Trend analyses in socioeconomic differences were also stratified by sex and age categories. Statistical significance was set at $P \leq 0.004$ due to multiple testing (Bonferroni correction: 0.05/14 for 14 countries).

Results

Sample characteristics

We included 325,184 adolescents after excluding 3,435 participants for missing data on SSB consumption (1.0% of the total sample; **Supplemental Figure 2**). FAS data were incomplete in 12,252 adolescents (3.8% overall; missing >10% of values in Slovakia in 2014 and 2018 and Croatia in 2014). The sample sizes and main characteristics of survey participants are presented overall and by country in **Table 1**. Overall, age and sex distributions were as follows: 51.2% were girls and 32.5%, 33.7%, and 33.8% were 11, 13, and 15 years old, respectively.

Sixteen-year trends in SSB consumption

In 2018, adjusted prevalences of daily SSB consumption ranged from 5.1% (95% CI: 4.4–5.8) in Estonia to 28.1% (95% CI: 26.2–30.0) in North Macedonia (**Table 2**, 5th column). The lowest proportions of daily SSB consumers in 2018 (<6%) were found in Estonia, Latvia, and Slovenia, and the highest proportions (>20%) were in Hungary, Slovakia, Bulgaria, North Macedonia, and Romania.

Between 2002 and 2006, daily SSB consumption increased in the Eastern zone (OR, 1.46; 95% CI: 1.35–1.58; $P < 0.001$; Table 2, 6th column). After 2006, it was reduced in all 3 geographical zones $0.71 \leq \text{OR} \leq 0.82$; $P < 0.001$; Table 2, 7th column). Looking at the overall linear trend between 2002 and 2018, the proportions of daily SSB consumers declined (OR, 0.79; 95% CI: 0.78–0.80; $P < 0.001$; Table 2, last column). More specifically, 10/14 countries experienced a decline (P for linear trends ≤ 0.004). Slovenia underwent the sharpest decline in daily SSB consumption (OR, 0.48; 95% CI: 0.45–0.50), followed by the Russian Federation (OR, 0.67; 95% CI: 0.64–0.70) and Bulgaria (OR, 0.71; 95% CI: 0.60–0.85; data from 2006 to 2018). The countries with smaller declines ($0.82 \leq \text{OR} \leq 0.90$) were Estonia, Poland, and North Macedonia. In Slovakia, the reduction observed in the daily SSB consumption prevalence over time might be due to variations in the months of data collection across survey years (June of 2006 and 2010; May of 2014; and March, April, and May of 2018).

Sixteen-year trends in socioeconomic differences in SSB consumption

Supplemental Table 1 shows that in 2002 (2006 for Slovakia, Bulgaria, and Romania), the proportions of daily SSB consumers were lower among the pupils with the lowest FAS than among those with highest the FAS in 11/14 countries ($0.26 \leq \text{OR} \leq 0.73$; $P \leq 0.004$).

Figure 1 (Baltic and Central) and **Figure 2** (Eastern) show that in 11/14 countries, adolescents from higher-affluence families had greater reductions in daily SSB consumption over time than those from lower-affluence families ($P \leq 0.004$). In the remaining 3 countries, the same pattern was observed but the differences were not statistically significant (Croatia, $P = 0.10$; Czechia, $P = 0.02$; and Slovenia, $P = 0.07$). Two different evolution patterns were observed: *1*) narrowing; or *2*) inversion of socioeconomic differences. Pattern 1 ("narrowing") was seen in Estonia, Latvia, North Macedonia, Romania, Russian Federation,

TABLE 1 Overall description of survey participants, by country, by geographical zone and in total, Health Behaviour in School-Aged Children study, 2002–2018

		Sex	Age categories			FAS[1] categories			
Countries	Total, *n*	Girls, %	11 y/o, %	13 y/o, %	15 y/o, %	Lower, %	Medium, %	Higher, %	Missing, %
Baltic									
Estonia	21,359	50.5	32.9	34.1	33.0	21.2	58.1	18.9	1.9
Latvia	21,687	51.9	34.2	34.2	31.6	20.8	58.3	18.3	2.6
Lithuania	25,966	49.0	34.0	33.7	32.3	20.7	58.5	18.4	2.5
Baltic zone	69,012	50.4	33.7	34.0	32.3	20.9	58.3	18.5	2.3
Central									
Croatia	26,115	50.6	31.3	32.5	36.1	20.4	56.6	18.5	4.5
Czechia	30,526	50.9	32.2	33.8	34.0	20.5	58.5	18.5	2.6
Hungary	19,846	53.0	32.7	34.8	32.5	20.9	58.5	19.0	1.6
Poland	25,645	50.9	31.9	32.8	35.3	21.1	58.1	18.6	2.3
Slovakia	19,533	51.0	30.4	38.0	31.7	18.4	51.0	16.7	13.9[2]
Slovenia	24,991	50.0	34.0	35.1	30.9	20.5	59.2	17.7	2.5
Central zone	146,656	51.0	32.1	34.3	33.6	20.4	57.2	18.2	4.2
Eastern									
Bulgaria	13,976	50.2	34.0	31.7	34.3	19.7	57.4	17.8	5.2
North Macedonia	21,515	50.7	31.5	32.9	35.6	20.5	59.1	18.4	2.0
Romania	18,181	52.3	31.9	31.9	36.1	19.4	56.5	18.0	6.0
Russian Federation	29,982	53.1	32.4	33.1	34.5	21.0	57.3	18.5	3.1
Ukraine	25,862	52.6	32.3	33.1	34.5	20.7	56.3	18.2	4.9
Eastern zone	109,516	52.0	32.3	32.7	35.0	20.4	57.3	18.2	4.1
All countries	325,184	51.2	32.5	33.7	33.8	20.5	57.5	18.3	3.8

Abbreviation: FAS, Family Affluence Scale.

[1]The FAS is based on 4 (2002–2010) to 6 (2014–2018) household wealth items.

[2]26.0% in 2018 due to a change in the questionnaire administration mode (from paper to online) and a lack of time to finish filling out the questionnaire (FAS-related questions at the end) due to restricted available time in the dedicated computer rooms.

and Ukraine, where socioeconomic differences were reduced between 2002 and 2018. Over time, the proportion of daily SSB consumers in the most affluent families became more similar to that found in the least affluent families. Pattern 2 ("inversion") was seen in Hungary, Poland, Slovakia, and Bulgaria, where the direction of socioeconomic differences was swapped between 2002/2006 and 2018. Thus, in these 4 countries and Czechia, the proportion of adolescents with lower affluence consuming SSB daily in 2018 tended to exceed the proportion of higher-affluence adolescents ($1.23 \leq OR \leq 1.42$; $0.009 \leq P \leq 0.05$; Supplemental Table 1).

Analyses of time trends in socioeconomic differences stratified by sex provided similar findings among girls and boys (**Table 3**). The exception was Slovenia, where a tendency for a larger reduction in daily SSB consumption over time was observed among the most affluent 20% of girls ($P = 0.015$), whereas socioeconomic differences did not evolve among Slovenian boys between 2002 and 2018 ($P = 0.62$). Stratification by age categories indicated that the interaction between FAS and time did not change according to age (data not shown).

Discussion

Adolescent daily consumption of SSBs decreased between 2002 and 2018 in 10/14 Eastern European countries, and the sizes of the declines varied considerably across countries. In 2018, 1 in 5 pupils still reported drinking SSBs every day in 5/14 countries. Also, in 11/14 countries, adolescents from higher-affluence families, who were more likely to consume SSBs daily in 2002, had greater reductions in consumption over time than those from lower-affluence families. Thus, socioeconomic differences narrowed or even reversed over time.

Towards a reduction of SSB consumption

The reduction in daily SSB consumption in most Eastern European countries was not entirely expected, since Singh et al. (6) showed a slight rise in daily SSB intake (about 20 mL/day) between 1990 and 2010 in both men and women from Central and Eastern Europe. The authors compiled data from food consumption surveys and considered all types of SSBs, using more robust dietary assessment methods than ours. Indeed, our data focused on consumption frequencies of sodas only, and we could not assess whether a replacement of sodas by other types of SSBs (e.g., fruit drinks, energy and sports drinks) occurred, as partially documented among Western adolescents (7). We did not find literature on this matter either. Of note, Singh et al. (6) did not specify the countries included in their trend analyses, thus limiting comparison with our country-specific results. The downward trend in SSB consumption among Eastern European adolescents is in line with observations in Western Europe (8–10) and the United States (7, 11). As expected, the start of the decline occurred later in most Eastern European countries (mainly after 2006) than in Nordic countries (8), Germany (9), and the United States (7, 11), where declines in SSB consumption were observed in the early 2000s or even before.

TABLE 2 Adjusted prevalences (95% CIs) of daily consumers of SSBs and ORs (95% CIs) of the time trends for 2 periods (2002–2006 and 2006–2018) and for overall linear time trends (2002–2018) by country, by geographical zone, and in total ($n = 325{,}184$)

Countries	2002[1]	2006[1]	2010[1]	2014[1]	2018[1]	OR 2002–2006[2]	OR 2006–2018[2]	OR 2002–2018[3]
Baltic								
Estonia	9.2	9.2	5.8	6.0	5.1	0.93	0.82[4]	0.82[4]
	(8.1–10.3)	(8.2–10.2)	(5.0–6.6)	(5.2–6.8)	(4.4–5.8)	(0.78–1.10)	(0.77–0.88)	(0.77–0.88)
Latvia	14.2	11.5	7.4	5.8	5.6	0.60[5]	0.84[4]	0.79[4]
	(12.7–15.7)	(10.3–12.7)	(6.5–8.4)	(5.1–6.5)	(4.8–6.4)	(0.45–0.81)	(0.76–0.92)	(0.74–0.85)
Lithuania[6]	9.1	13.4	7.4	10.7	12.7	1.38[4]	0.81[4]	0.94
	(8.2–9.9)	(12.2–14.5)	(6.6–8.3)	(9.7–11.7)	(11.1–14.2)	(1.20–1.60)	(0.75–0.87)	(0.90–0.99)
Baltic zone	10.0	11.1	6.6	7.2	7.0	1.17	0.82[4]	0.86[4]
	(8.1–12.0)	(9.0–13.2)	(5.3–8.0)	(5.8–8.7)	(5.5–8.4)	(1.04–1.32)	(0.79–0.85)	(0.84–0.89)
Central								
Croatia	31.7	30.5	25.3	22.6	15.4	0.99	0.75[4]	0.75[4]
	(29.6–33.7)	(28.6–32.4)	(23.8–26.8)	(21.1–24.0)	(14.2–16.7)	(0.87–1.12)	(0.72–0.79)	(0.72–0.79)
Czechia	28.0	30.1	21.6	14.4	13.2	1.03	0.71[4]	0.74[4]
	(26.3–29.6)	(28.4–31.9)	(20.0–23.1)	(13.2–15.6)	(12.4–13.9)	(0.91–1.17)	(0.68–0.73)	(0.72–0.76)
Hungary[6]	31.4	30.3	26.7	29.0	22.6	0.98	0.92	0.93
	(28.5–34.2)	(27.4–33.1)	(24.5–29.0)	(26.4–31.5)	(20.5–24.7)	(0.81–1.18)	(0.85–0.99)	(0.88–0.98)
Poland	24.6	25.9	26.7	22.6	15.5	1.17[5]	0.82[4]	0.90[4]
	(23.2–26.0)	(24.4–27.5)	(25.0–28.4)	(21.1–24.1)	(14.3–16.6)	(1.05–1.30)	(0.78–0.86)	(0.87–0.93)
Slovakia[6,7]	—	36.6	36.5	23.7	20.8	—	—	0.94[8]
	—	(33.9–39.3)	(34.9–38.1)	(22.5–25.0)	(19.1–22.6)	—	—	(0.84–1.05)
Slovenia	39.2	24.6	37.0	6.2	5.8	0.39	0.48[4]	0.48[4]
	(37.1–41.2)	(23.1–26.1)	(35.3–38.8)	(5.5–6.9)	(5.1–6.4)	(0.20–0.79)	(0.45–0.50)	(0.45–0.50)
Central zone	31.5	29.4	28.6	18.6	14.6	0.99	0.71[4]	0.76[4]
	(27.7–35.3)	(25.7–33.0)	(25.1–32.2)	(15.9–21.3)	(12.4–16.8)	(0.93–1.05)	(0.70–0.73)	(0.74–0.77)
Eastern								
Bulgaria[6,7]	—	50.4	—	34.1	25.8	—	—	0.71[4]
	—	(48.5–52.2)	—	(32.3–35.8)	(24.3–27.3)	—	—	(0.60–0.85)
North Macedonia[6]	34.3	35.7	30.2	29.4	28.1	0.92	0.88[5]	0.88[5]
	(32.0–36.7)	(33.7–37.8)	(28.3–32.2)	(27.4–31.5)	(26.2–30.0)	(0.78–1.08)	(0.81–0.96)	(0.81–0.96)
Romania[6,7]	—	37.4	29.6	24.6	20.1	—	—	0.78[5]
	—	(35.1–39.7)	(27.7–31.4)	(22.6–26.6)	(18.4–21.8)	—	—	(0.67–0.90)
Russian Federation[6]	20.7	25.1	21.3	9.6	8.8	1.48[5]	0.64[4]	0.67[4]
	(19.5–22.0)	(23.7–26.4)	(19.8–22.7)	(8.7–10.6)	(7.9–9.8)	(1.14–1.91)	(0.61–0.67)	(0.64–0.70)
Ukraine[6]	15.7	30.9	15.6	13.2	14.1	2.24[4]	0.48[4]	0.92
	(14.3–17.1)	(29.2–32.6)	(14.5–16.7)	(12.0–14.3)	(13.1–15.1)	(1.97–2.56)	(0.71–0.53)	(0.86–0.99)
Eastern zone	27.6	35.6	25.9	20.6	18.3	1.46[4]	0.75[4]	0.81[4]
	(20.0–35.2)	(27.0–44.3)	(18.7–33.2)	(14.4–26.8)	(12.7–24.0)	(1.35–1.58)	(0.73–0.77)	(0.79–0.84)
All countries	24.5	26.5	21.5	15.7	13.2	1.09[4]	0.74[4]	0.79[4]
	(18.4–30.6)	(20.1–32.9)	(16.0–27.1)	(11.3–20.1)	(9.4–17.0)	(1.05–1.13)	(0.73–0.75)	(0.78–0.80)

Abbreviation: SSB, sugar-sweetened beverage.

[1]Prevalences (95% CIs) estimated by multilevel logistic models (dependent variable: daily SSB consumption) adjusted for sex and age categories.

[2]Time trends estimated by multilevel logistic models adjusted for sex, age categories, and months of data collection (ORs for time as a continuous variable), looking at 2-piecewise linear trends between 2002 and 2006 and between 2006 and 2018.

[3]Time trends estimated by multilevel logistic models adjusted for sex, age categories, and months of data collection (ORs for time as a continuous variable), looking at the overall linear trends between 2002 and 2018.

[4]$P < 0.001$.

[5]$P \leq 0.004$ (Bonferroni correction).

[6]Variations found in the seasons of data collection across survey years.

[7]No data in 2002. Bulgaria also had no data in 2010.

[8]Seasonal effect observed (data collected in June in 2006 and 2010, in May in 2014 and in March, April and May in 2018, which were cooler months, potentially associated with less consumption of SSBs).

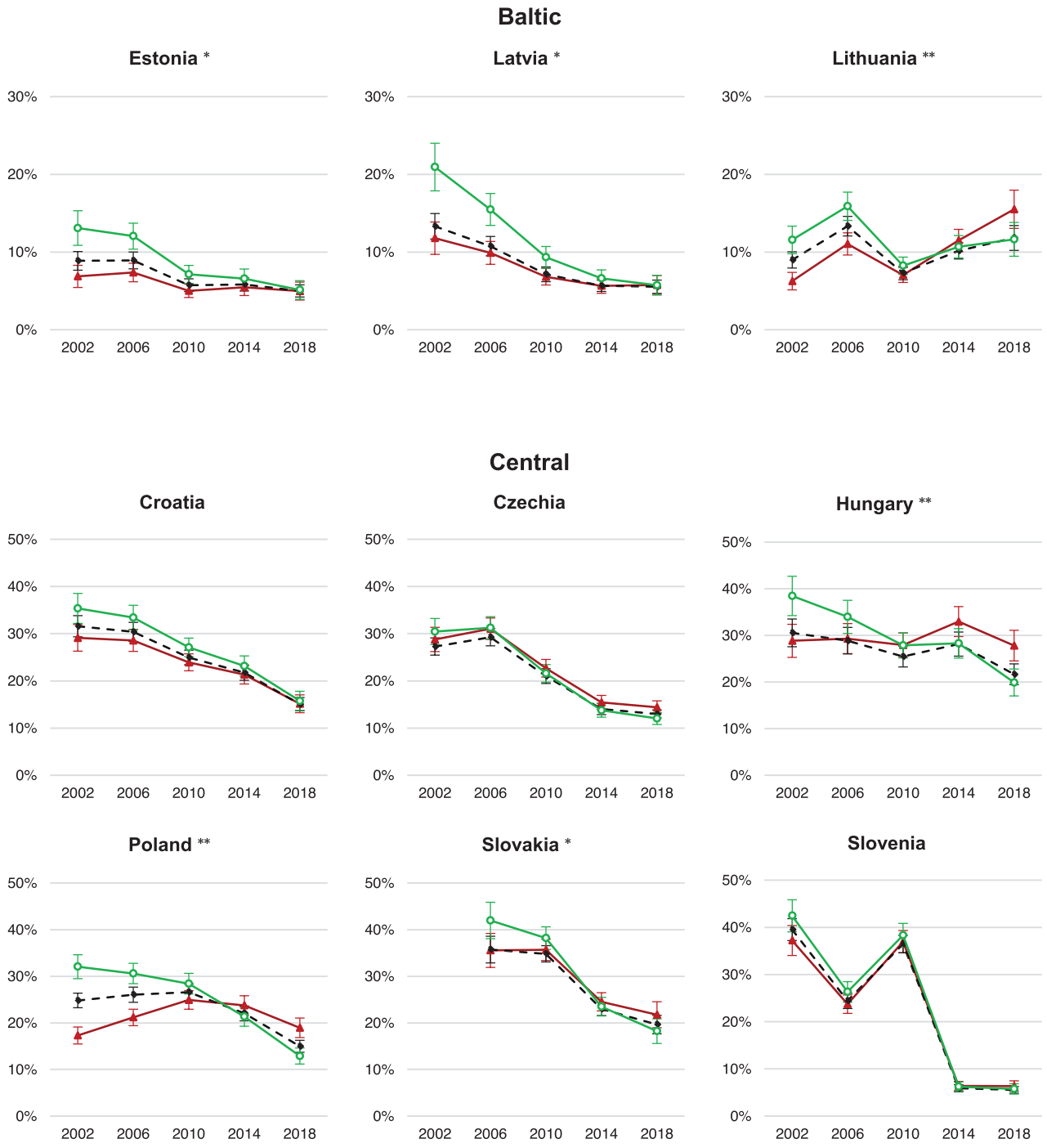

FIGURE 1 Trends in prevalence (95% CI) of daily consumers of SSBs, by country and by FAS category in the Baltic and Central zones [$^{*}P \leq 0.004$ (Bonferroni correction); $^{**}P < 0.001$ for interaction terms FAS∗time, indicating that the 20% most affluent adolescents reduced their consumption over time more than the 20% least affluent ones; the multilevel logistic models (dependent variable: daily SSB consumption) were adjusted for sex, age categories, survey years, and FAS categories; $n = 207{,}858$]. The y-axis scales on the first 3 graphs (0%–30%) are different from those in the other graphs (0%–50%) and from those in Figure 2 (0%–70%). Abbreviations: FAS, Family Affluence Scale; SSB, sugar-sweetened beverage.

Changing socioeconomic differences in SSB consumption

As far as we know, no other study has assessed how the association between SSBs and SEP has evolved over time in Eastern Europe. The fact that reductions in daily SSB consumption were faster among higher-SEP adolescents was expected in the context of the nutrition transition. According to the fundamental cause theory (42, 43), this could be explained by a wider range of "flexible resources" (e.g., knowledge, wealth, and social networks) among higher-SEP groups, which allow them to improve health-related behaviors more easily

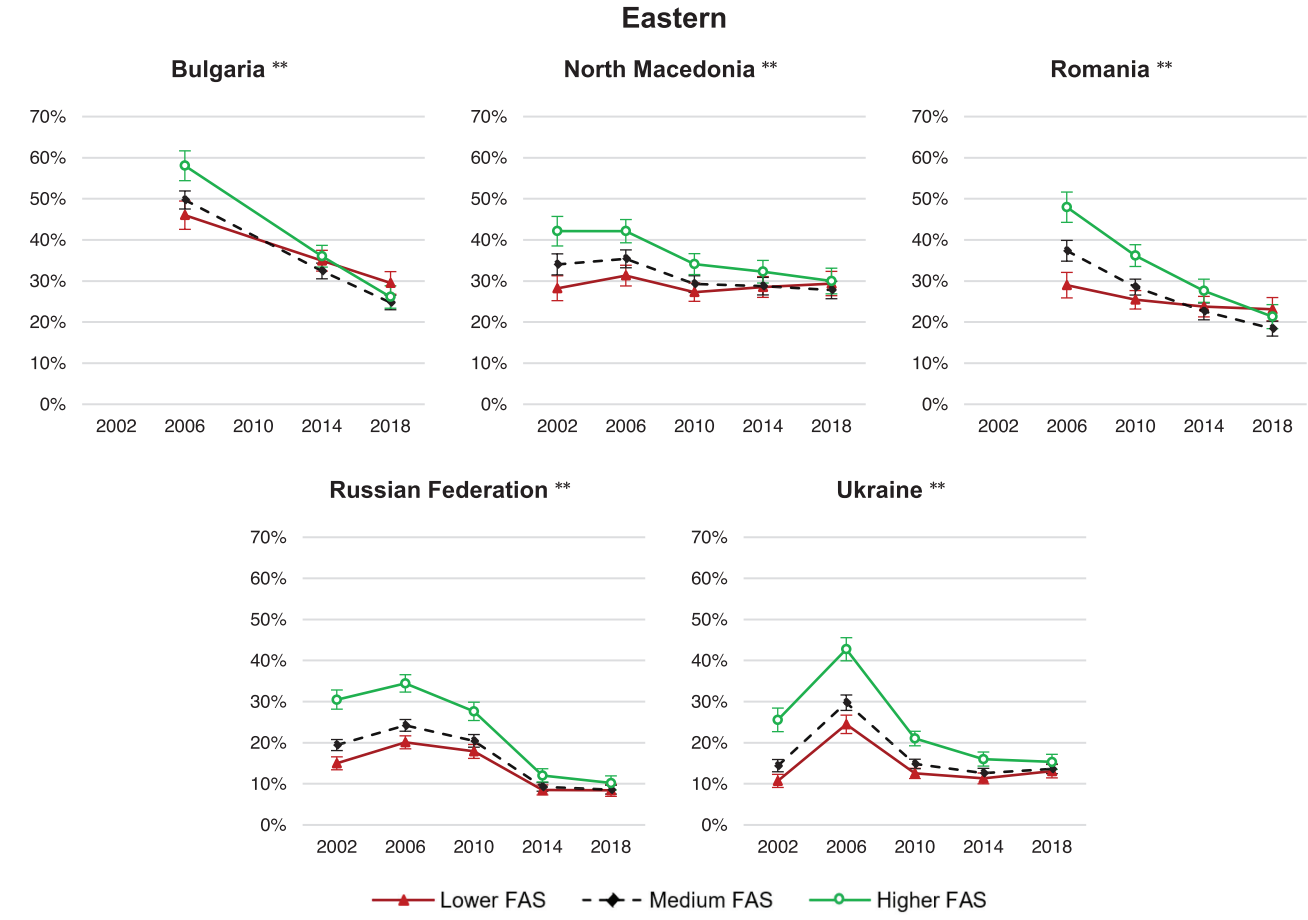

FIGURE 2 Trends in prevalence (95% CI) of daily consumers of SSBs, by country and by FAS category in the Eastern zone [$^{*}P \leq 0.004$ (Bonferroni correction); $^{**}P < 0.001$ for interaction terms FAS*time, indicating that the 20% most affluent adolescents reduced their consumption over time more than the 20% least affluent ones; the multilevel logistic models (dependent variable: daily SSB consumption) were adjusted for sex, age categories, survey years, and FAS categories; $n = 105{,}074$]. The y-axis scales on these graphs (0%–70%) are different from those in Figure 1 (Baltic zone, 0%–30%; Central zone, 0%–50%). Abbreviations: FAS, Family Affluence Scale; SSB, sugar-sweetened beverage.

and quickly. Additionally, disparities in physical and economic access to sodas, other types of SSBs (44–46), and heathier options (e.g., water and milk) (47, 48) may have played a role in this social patterning evolution. Indeed, Coke became more affordable between 1990 and 2016 in Eastern Europe due to income increases and soda price decreases, while bottled water remained more expensive than Coke during this period (47). This may have contributed to a smaller decline in daily SSB consumption in lower-SEP groups.

In 2018, adolescents of lower affluence were more likely to drink SSBs daily than those of higher affluence in Czechia, Hungary, Poland, Slovakia, and Bulgaria. Thus, these 5 countries now experience socioeconomic inequalities in adolescent SSB consumption, similar to those found in most Western countries (10, 11, 28, 29, 49). Few publications in Eastern Europe, beyond the articles using HBSC data (31, 50, 51), studied the cross-sectional association between SSBs and SEP among adults (old data) (52) or children (53). The latter study documented an association between lower parental education and greater consumption frequency of SSBs among 2- to 9-year-olds in Hungary but not in Estonia [2007–2008 data, Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and infantS (IDEFICS) study] (53). Ten years later (2018), we also documented the presence of socioeconomic inequalities among Hungarian adolescents ("inversion" pattern) and no socioeconomic differences in Estonian adolescents ("narrowing" pattern). This may indicate that Eastern European countries are at different stages of the nutrition transition. Of note, the presence of socioeconomic differences in dietary behaviors may vary depending on the SEP indicators used. For instance, 2002 HBSC data in Eastern Europe had shown a positive association between daily SSB consumption and family material affluence but no association with parental occupation (54).

Public health implications

In Eastern Europe, 20% of pupils aged 11 to 15 years still report drinking SSBs every day in one-third of countries. In addition, more and more countries are experiencing socioeconomic inequalities in SSB consumption [and obesity (49)]. This underlines the need for public health interventions to tackle socioeconomic inequalities in diet and obesity. The 2 WHO

TABLE 3 ORs (95% CIs) of the time trends in the association between daily consumption of SSBs and FAS category (reference group = the 20% most affluent adolescents, compared with the 60% medium affluent and the 20% the least affluent ones), by sex, by country, by geographical zone, and in total (n = 161,432 girls; 151,500 boys)

	Girls			Boys		
Countries	Medium FAS OR (95% CI)[1]	Lower FAS OR (95% CI)[1]	P value[1]	Medium FAS OR (95% CI)[1]	Lower FAS OR (95% CI)[1]	P value[1]
Baltic						
Estonia	1.02 (0.87–1.21)	1.24 (1.02–1.52)	0.035	1.18 (1.05–1.33)	1.16 (1.00–1.35)	0.05
Latvia	1.21 (1.05–1.40)	1.22 (1.02–1.47)	0.028	1.12 (1.00–1.26)	1.19 (1.04–1.36)	0.013
Lithuania	1.04 (0.92–1.17)	1.35 (1.17–1.57)	<0.001	1.13 (1.02–1.24)	1.29 (1.14–1.46)	<0.001
Baltic zone	1.09 (1.00–1.18)	1.30 (1.17–1.43)	<0.001	1.15 (1.08–1.22)	1.23 (1.13–1.32)	<0.001
Central						
Croatia	1.00 (0.92–1.09)	1.06 (0.96–1.17)	0.28	1.05 (0.97–1.14)	1.07 (0.97–1.18)	0.18
Czechia	1.05 (0.98–1.13)	1.08 (0.99–1.19)	0.09	1.07 (0.99–1.15)	1.07 (0.99–1.17)	0.10
Hungary	1.16 (1.05–1.28)	1.35 (1.20–1.52)	<0.001	1.10 (1.00–1.21)	1.20 (1.08–1.34)	0.001
Poland	1.14 (1.05–1.24)	1.42 (1.28–1.57)	<0.001	1.17 (1.09–1.27)	1.38 (1.26–1.52)	<0.001
Slovakia	1.14 (1.00–1.30)	1.24 (1.06–1.45)	0.006	1.11 (0.98–1.26)	1.16 (1.00–1.34)	0.05
Slovenia	1.02 (0.91–1.14)	1.18 (1.03–1.36)	0.015	1.02 (0.93–1.13)	1.03 (0.92–1.16)	0.62
Central zone	1.08 (1.04–1.12)	1.21 (1.16–1.27)	<0.001	1.08 (1.05–1.12)	1.15 (1.10–1.20)	<0.001
Eastern						
Bulgaria	1.11 (0.99–1.25)	1.21 (1.06–1.38)	0.005	1.06 (0.94–1.19)	1.28 (1.11–1.46)	<0.001
North Macedonia	1.08 (0.99–1.17)	1.20 (1.09–1.33)	<0.001	1.05 (0.97–1.13)	1.14 (1.03–1.26)	0.011
Romania	1.21 (1.07–1.36)	1.53 (1.33–1.77)	<0.001	1.01 (0.89–1.15)	1.29 (1.11–1.50)	0.001
Russian Federation	1.15 (1.05–1.25)	1.15 (1.02–1.29)	0.018	1.09 (1.00–1.19)	1.26 (1.13–1.41)	<0.001
Ukraine	1.20 (1.10–1.32)	1.33 (1.19–1.49)	<0.001	1.16 (1.06–1.26)	1.21 (1.09–1.35)	<0.001
Eastern zone	1.14 (1.10–1.19)	1.28 (1.22–1.35)	<0.001	1.10 (1.06–1.15)	1.25 (1.19–1.31)	<0.001
All countries	1.10 (1.07–1.13)	1.24 (1.20–1.28)	<0.001	1.10 (1.07–1.12)	1.19 (1.16–1.23)	<0.001

Abbreviations: FAS, Family Affluence Scale; SSB, sugar-sweetened beverage.

[1]Time trends were estimated by multilevel logistic models (dependent variable: daily SSB consumption) adjusted for sex, age categories, survey years, and FAS categories (ORs for time*FAS categories, time as a continuous variable). OR >1 and $P \leq 0.004$ (Bonferroni correction) indicate that the 20% least affluent adolescents reduced their daily SSB consumption less over time than the 20% most affluent ones (reference group).

reports "Ending Childhood Obesity" (55) and "European Food and Nutrition Action Plan 2015–2020" (56) have highlighted the importance of implementing comprehensive programs that both promote healthy eating and reduce socioeconomic inequalities in diet. The sharp declines in daily SSB consumption observed across all SEP groups between 2010 and 2014 in Slovenia and between 2006 and 2014 in Bulgaria may speak in favor of nutrition standards for food allowed in schools, which are considered as a cost-effective measure to reduce childhood obesity (57). Indeed, Slovenia introduced mandatory dietary guidelines and a ban on vending machines (58) in mid-2010 (after the 2010 HBSC data collection), and Bulgaria restricted physical access to SSBs in school premises as of 2009 (59).

Strengths and limitations

The present study has several strengths. First, it involved large, population-based samples; stratified to be nationally representative; and with high participation rates at the school and pupil levels. Second, the protocol was standardized across the 5 survey years and the 14 countries, allowing the comparison of cross-national long-term trends. Third, we used a validated SEP indicator for adolescents (35–37). The study also has some limitations. First, we could only investigate the consumption of sodas, since no data on other types of SSBs, artificially sweetened beverages, or water were available. Second, we limited the analysis to the prevalences of daily SSB consumers, as the HBSC collects only information on consumption frequency and not on quantitative intake (e.g., in mL/day). Third, we could not explain the peak in the prevalence of daily SSB consumers found in Slovenia in 2010. Fourth, reliability and validity of the FFQ were moderate, with a slight overestimation of the weekly consumption frequency as compared to 7-day food records. Therefore, the prevalences of daily SSB consumption might be overestimated. We may, however, suppose that overestimations remained constant over time. Fifth, self-reports of dietary intake can be biased by social desirability (60). We cannot rule out that SSB consumption underreporting might have increased over time due to rising awareness of SSBs' negative consequences on health (61). Sixth, little changes in the item formulation "Coke or other soft drinks that contain sugar," as well as changes in the question order across survey years, were possible, albeit discouraged by the international protocol. Seventh, the FAS reflects only 1 dimension of SEP and may not distinguish well between pupils within large countries with heterogeneous and evolving contexts (e.g., urban compared with rural, or changes in the material value of computers between 2002 and 2018) (62). Furthermore, the FAS construction changed between 2010 and 2014 (addition of 2 items) to take societal changes into account, but this increased the likelihood of missing values.

Conclusions

Adolescent daily consumption of SSBs (sodas) declined between 2002 and 2018 in Eastern Europe but remains high in some countries. Further scrutiny of nutrition programs implemented

in countries with low prevalences of daily SSB consumers (e.g., Baltic countries) and with the largest reductions over time would be informative. In line with the nutrition transition, daily SSB consumption was reduced at faster rates over time among higher-affluence adolescents than those of lower affluence. Thus, the highest SSB consumption levels are progressively observed in the least-affluent adolescents, as in Western countries (10, 11, 28, 29, 49). Further analyses of associations between SEP and broader dietary patterns are needed in Eastern Europe. All in all, this paper can serve as a first step to evaluate past public health interventions and plan future diet-related policies and programs in the context of a nutrition transition.

HBSC is an international study carried out in collaboration with the WHO Regional Office for Europe. Candace Currie (Glasgow Caledonian University) was the International Coordinator for the 2002 to 2014 surveys and Jo Inchley (University of Glasgow) for the 2018 survey. Oddrun Samdal (University of Bergen) was the Data Bank Manager between 2002 and 2018. The following principal investigators conducted data collection: Estonia (Leila Oja, Katrin Aasvee, and Mai Maser), Latvia (Iveta Pudule), Lithuania (Kastytis Smigelskas and Apolinaras Zaborskis), Croatia (Ivana Pavic Simetin and Marina Kuzman), Czechia (Michal Kalman and Ladislav Csemy), Hungary (Ágnes Németh and Anna Aszmann), Poland (Joanna Mazur, Agnieszka Malkowska-Szkutnik and Barbara Woynarowska), Slovakia (Andrea Madarasova Geckova, Elena Morvicova, and Miro Bronis), Slovenia (Helena Jericek and Eva Stergar), Bulgaria (Lidiya Vasileva), North Macedonia (Lina Kostarova Unkovska), Romania (Adriana Baban), Russian Federation (Anna Matochkina, Oleg Churganov, and Alexander Komkov) and Ukraine (Olga Balakireva). For details, see http://www.hbsc.org. We thank Pierre-Alexandre Fonta for his support in interpreting the Ridit-transformation formula.

The authors' responsibilities were as follows—AC and KC: designed the manuscript, wrote the manuscript, and had primary responsibility for the final content; AC: analyzed the data; AD, A-SF, and MK: provided literature; and all authors: read and approved the final manuscript.

Author disclosures: The authors report no conflicts of interest.

Data Availability

Data described in the manuscript, code book, and analytic code will be made available upon request. HBSC protocols, questionnaires, and data from survey years 2002, 2006, 2010, 2014 (embargo on 2018 data) can be accessed via a request to the HBSC Data Management Centre (dmc@hbsc.org). For further information, see http://www.uib.no/en/hbscdata.

References

1. Azais-Braesco V, Sluik D, Maillot M, Kok F, Moreno LA. A review of total & added sugar intakes and dietary sources in Europe. Nutr J 2017;16(1):6.
2. Zupanic N, Hristov H, Gregoric M, Blaznik U, Delfar N, Korousic Seljak B, Ding EL, Fidler Mis N, Pravst I. Total and free sugars consumption in a Slovenian population representative sample. Nutrients 2020;12(6):1729.
3. Moynihan PJ, Kelly SA. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. J Dent Res 2014;93(1):8–18.
4. Luger M, Lafontan M, Bes-Rastrollo M, Winzer E, Yumuk V, Farpour-Lambert N. Sugar-sweetened beverages and weight gain in children and adults: a systematic review from 2013 to 2015 and a comparison with previous studies. Obes Facts 2017;10(6):674–93.
5. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. Am J Clin Nutr 2013;98(4):1084–102.
6. Singh GM, Micha R, Khatibzadeh S, Shi P, Lim S, Andrews KG, Engell RE, Ezzati M, Mozaffarian D. Global, regional, and national consumption of sugar-sweetened beverages, fruit juices, and milk: a systematic assessment of beverage intake in 187 countries. PLoS One 2015;10(8):e0124845.
7. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in beverage consumption among children and adults, 2003–2014. Obesity 2018;26(2):432–41.
8. Fismen AS, Smith OR, Torsheim T, Rasmussen M, Pedersen Pagh T, Augustine L, Ojala K, Samdal O. Trends in food habits and their relation to socioeconomic status among Nordic adolescents 2001/2002–2009/2010. PLoS One 2016;11(2):e0148541.
9. Perrar I, Schadow AM, Schmitting S, Buyken AE, Alexy U. Time and age trends in free sugar intake from food groups among children and adolescents between 1985 and 2016. Nutrients 2019;12(1):20.
10. Bates B, Collins D, Cox L, Nicholson S, Page P, Roberts C, Steer T, Swan G. National Diet and Nutrition Survey. Years 1 to 9 of the rolling programme (2008/2009–2016/2017): time trend and income analyses. London (UK): Public Health England; 2019.
11. Mendez MA, Miles DR, Poti JM, Sotres-Alvarez D, Popkin BM. Persistent disparities over time in the distribution of sugar-sweetened beverage intake among children in the United States. Am J Clin Nutr 2019;109(1):79–89.
12. von Philipsborn P, Stratil JM, Burns J, Busert LK, Pfadenhauer LM, Polus S, Holzapfel C, Hauner H, Rehfuess E. Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. Cochrane Database Syst Rev 2019;6:CD012292.
13. Avery A, Bostock L, McCullough F. A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness. J Hum Nutr Diet 2015;28:52–64.
14. Fismen AS, Smith OR, Torsheim T, Samdal O. A school based study of time trends in food habits and their relation to socio-economic status among Norwegian adolescents, 2001–2009. Int J Behav Nutr Phys Act 2014;11(1):115.
15. Voracova J, Sigmund E, Sigmundova D, Kalman M. Changes in eating behaviours among Czech children and adolescents from 2002 to 2014 (HBSC study). Int J Environ Res Public Health 2015;12(12):15888–99.
16. Zaborskis A, Lagunaite R, Busha R, Lubiene J. Trend in eating habits among Lithuanian school-aged children in context of social inequality: three cross-sectional surveys 2002, 2006 and 2010. BMC Public Health 2012;12(1):52.
17. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. Lancet Diabetes Endocrinol 2016;4(2):174–86.
18. Arsenault B, Taskinen MR, Despres JP. Prevalence and 2010–15 secular trends in sugar-sweetened beverages sales in Europe and the Middle East. Atherosclerosis 2016;252:e210–1.
19. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 2012;70(1):3–21.
20. Ulijaszek SJ, Koziel S. Nutrition transition and dietary energy availability in Eastern Europe after the collapse of communism. Econ Hum Biol 2007;5(3):359–69.
21. Baker P, Machado P, Santos T, Sievert K, Backholer K, Hadjikakou M, Russell C, Huse O, Bell C, Scrinis G,, et al. Ultra-processed foods and the nutrition transition: global, regional and national trends, food systems transformations and political economy drivers. Obes Rev 2020;21(12):e13126.
22. Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. Nutr Rev 1997;55(2):31–43.
23. Popkin BM. Nutritional patterns and transitions. Popul Dev Rev 1993;19(1):138–57.
24. Popkin BM. The nutrition transition: an overview of world patterns of change. Nutr Rev 2004;62:S140–3.
25. Mayen AL, Marques-Vidal P, Paccaud F, Bovet P, Stringhini S. Socioeconomic determinants of dietary patterns in low- and middle-income countries: a systematic review. Am J Clin Nutr 2014;100(6):1520–31.
26. Manyanga T, Tremblay MS, Chaput JP, Katzmarzyk PT, Fogelholm M, Hu G, Kuriyan R, Kurpad A, Lambert EV, Maher C, et al. Socioeconomic status and dietary patterns in children from around the world: different associations by levels of country human development? BMC Public Health 2017;17(1):457.

27. Desbouys L, Mejean C, De Henauw S, Castetbon K. Socio-economic and cultural disparities in diet among adolescents and young adults: a systematic review. Public Health Nutr 2020;23(5):843–60.
28. Desbouys L, De Ridder K, Rouche M, Castetbon K. Food consumption in adolescents and young adults: age-specific socio-economic and cultural disparities (Belgian Food Consumption Survey 2014). Nutrients 2019;11(7):1520.
29. Mensink GBM, Schienkiewitz A, Rabenberg M, Borrmann A, Richter A, Haftenberger M. Konsum zuckerhaltiger erfrischungsgetränke bei kindern und jugendlichen in Deutschland–Querschnittergebnisse aus KiGGS welle 2 und trends [German] (Consumption of sugary soft drinks in children and young people in Germany–cross-sectional results from KiGGS wave 2 and trends). J Health Monit 2018;3(1):32–29.
30. Parizkova J. Dietary habits and nutritional status in adolescents in Central and Eastern Europe. Eur J Clin Nutr 2000;54:S1, S36–40.
31. Zaborskis A, Grincaite M, Kavaliauskiene A, Tesler R. Family structure and affluence in adolescent eating behaviour: a cross-national study in forty-one countries. Public Health Nutr 2021:24(9):2521–32.
32. HBSC International Coordinating Centre. Publications: International reports. [Internet]. St Andrews (UK): University of St Andrews; 2021. [Accessed 2021 Jan 13]. Available from: http://www.hbsc.org/publications/international/.
33. Inchley J, Currie C, Cosma A, Samdal O. Health Behaviour in School-Aged Children study protocol: background, methodology and mandatory items for the 2017/18 survey. St Andrews (UK): Child and Adolescent Health Research Unit; 2018.
34. Vereecken CA, Maes L. A Belgian study on the reliability and relative validity of the Health Behaviour in School-Aged Children food-frequency questionnaire. Public Health Nutr 2003;6(6):581–8.
35. Currie CE, Elton RA, Todd J, Platt S. Indicators of socioeconomic status for adolescents: the WHO Health Behaviour in School-aged Children Survey. Health Educ Res 1997;12(3):385–97.
36. Torsheim T, Cavallo F, Levin KA, Schnohr C, Mazur J, Niclasen B, Currie C; the FAS Development Study Group. Psychometric validation of the revised family affluence scale: a latent variable approach. Child Indic Res 2016;9(3):771–84.
37. Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. Soc Sci Med 2008;66(6):1429–36.
38. Elgar FJ, Xie A, Pförtner T-K, White J, Pickett KE. Assessing the view from bottom: how to measure socioeconomic position and relative deprivation in adolescents. In: SAGE Research Methods Cases Part 2. London (UK): SAGE Publishing; 2017.
39. Stelmach-Mardas M, Kleiser C, Uzhova I, Penalvo JL, La Torre G, Palys W, Lojko D, Nimptsch K, Suwalska A, Linseisen J, et al. Seasonality of food groups and total energy intake: a systematic review and meta-analysis. Eur J Clin Nutr 2016;70(6):700–8.
40. Goiana-da-Silva F, Severo M, Cruz ESD, Gregorio MJ, Allen LN, Muc M, Nunes AM, Torres D, Miraldo M, Ashrafian H, et al. Projected impact of the Portuguese sugar-sweetened beverage tax on obesity incidence across different age groups: a modelling study. PLoS Med 2020;17(3):e1003036.
41. Zaborskis A, Moceviciene R, Iannotti RJ. The influence of chronological period of data collection on differences in reported dietary intake among school-aged children surveyed in 39 countries. J Nutr Educ Behav 2014;46(5):359–69.
42. Link BG, Phelan J. Social conditions as fundamental causes of disease. J Health Soc Behav 1995;35:80;Spec No:80-94.
43. Phelan JC, Link BG, Tehranifar P. Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications. J Health Soc Behav 2010;51(Suppl 1):S28–40.
44. Lovasi GS, Hutson MA, Guerra M, Neckerman KM. Built environments and obesity in disadvantaged populations. Epidemiol Rev 2009;31(1):7–20.
45. Papas MA, Alberg AJ, Ewing R, Helzlsouer KJ, Gary TL, Klassen AC. The built environment and obesity. Epidemiol Rev 2007;29(1):129–43.
46. Cummins S, Macintyre S. Food environments and obesity–neighbourhood or nation? Int J Epidemiol 2006;35(1):100–4.
47. Blecher E, Liber AC, Drope JM, Nguyen B, Stoklosa M. Global trends in the affordability of sugar-sweetened beverages, 1990–2016. Prev Chronic Dis 2017;14:160406.
48. Watters CA, Corrado RS, Chaloupka FJ. Prices of healthy and unhealthy beverages in high and low per capita income areas. Hawaii J Med Public Health 2013;72(3):76–9.
49. Inchley J, Currie D, Budisavljevic S, Torsheim T, Jåstad A, Cosma A, Kelly C, Arnarsson AM, Samdal O. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behaviour in School-Aged Children (HBSC) survey in Europe and Canada. International report. Volume 2. Key data. Copenhagen (Denmark): WHO Regional Office for Europe; 2020.
50. Voracova J, Sigmund E, Sigmundova D, Kalman M. Family affluence and the eating habits of 11- to 15-year-old Czech adolescents: HBSC 2002 and 2014. Int J Environ Res Public Health 2016;13(10):1034.
51. Inchley J, Currie D, Jewell J, Breda J, Barnekow V. Adolescent obesity and related behaviours: trends and inequalities in the WHO European Region, 2002–2014. Copenhagen (Denmark): WHO Regional Office for Europe; 2017.
52. Garduno-Alanis A, Malyutina S, Pajak A, Stepaniak U, Kubinova R, Denisova D, Pikhart H, Peasey A, Bobak M, Stefler D. Association between soft drink, fruit juice consumption and obesity in Eastern Europe: cross-sectional and longitudinal analysis of the HAPIEE study. J Hum Nutr Diet 2020;33(1):66–77.
53. Fernandez-Alvira JM, Mouratidou T, Bammann K, Hebestreit A, Barba G, Sieri S, Reisch L, Eiben G, Hadjigeorgiou C, Kovacs E, et al. Parental education and frequency of food consumption in European children: the IDEFICS study. Public Health Nutr 2013;16(3):487–98.
54. Vereecken CA, Inchley J, Subramanian SV, Hublet A, Maes L. The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. Eur J Public Health 2005;15(3):224–32.
55. WHO. Report of the Commission on Ending Childhood Obesity. Geneva (Switzerland): WHO; 2016.
56. WHO Regional Office for Europe. European Food and Nutrition Action Plan 2015–2020. Copenhagen (Denmark): WHO Regional Office for Europe; 2015.
57. Gortmaker SL, Wang YC, Long MW, Giles CM, Ward ZJ, Barrett JL, Kenney EL, Sonneville KR, Sadaf Afzal A, Resch SC, et al. Three interventions that reduce childhood obesity are projected to save more than they cost to implement. Health Aff 2015;34(11):1932–9.
58. Gregoric M, Pograjc L, Pavlovec A, Simcic M, Gabrijelcic Blenkus M. School nutrition guidelines: overview of the implementation and evaluation. Public Health Nutr 2015;18(9):1582–92.
59. Lloyd-Williams F, Bromley H, Orton L, Hawkes C, Taylor-Robinson D, O'Flaherty M, McGill R, Anwar E, Hyseni L, Moonan M, et al. Smorgasbord or symphony? Assessing public health nutrition policies across 30 European countries using a novel framework. BMC Public Health 2014;14(1):1195.
60. Hebert JR, Clemow L, Pbert L, Ockene IS, Ockene JK. Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. Int J Epidemiol 1995;24(2):389–98.
61. Lissner L. Measuring food intake in studies of obesity. Public Health Nutr 2002;5(6a):889–92.
62. Makransky G, Schnohr CW, Torsheim T, Currie C. Equating the HBSC Family Affluence Scale across survey years: a method to account for item parameter drift using the Rasch model. Qual Life Res 2014;23(10):2899–907.