Appetite 198 (2024) 107339

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Country-level sociocultural context and socioeconomic inequalities in adolescent dietary behaviours: A multilevel analysis in 21 European countries

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ARTICLE INFO

Keywords:
Youth
Eating behaviour
Socioeconomic status
Health inequalities
Multilevel regression analysis

ABSTRACT

Studies to date have predominantly focused on countries' socioeconomic conditions (e.g., income inequality) to explain cross-national differences in socioeconomic inequalities in adolescent health (behaviours). However, the potential explanatory role of sociocultural contexts at country-level remains underexamined. This study examined whether the country-level sociocultural context and changes thereof were associated with adolescent socioeconomic inequalities in dietary behaviours. International comparative data of 344,352 adolescents living in 21 countries participating in 2002, 2006, 2010 and 2014 waves of the Health Behaviour in School-aged Children (HBSC) survey were combined with aggregated levels of openness-to-change from the European Social Survey (ESS). Four dietary behaviours (i.e., fruit, vegetable, sweets and soft drink consumption) and two measures of socioeconomic status (SES) on the individual level (i.e., family affluence scale [FAS] and occupational social class [OSC]) were studied. Multilevel logistic regression analyses returned contrasting results for the two SES measures used. In countries with higher levels of openness-to-change, smaller FAS inequalities in daily fruit, sweets and soft drink consumption were observed, but no such inequalities were found for vegetable consumption. Conversely, in these countries, larger OSC inequalities in soft drink consumption were found. Country-specific changes in openness-to-change over time were not associated with the magnitude of adolescent dietary inequalities. Findings underscore the importance of including country-level sociocultural contexts to improve the understanding of cross-national differences in socioeconomic inequalities in adolescents' diets. Future studies, spanning a longer timeframe, are required to examine whether such associations exist within countries over time since our timeframe might have been too small to capture these long-term trends.

1. Introduction

Healthy dietary habits are vital for biological and cognitive development (Das et al., 2017) and in preventing overweight and obesity during adolescence as well as related noncommunicable diseases later in life (Freemark, 2018). Although an international report has established improved dietary behaviours among adolescents in recent years (Inchley et al., 2020), adherence to current dietary recommendations remains suboptimal. For example, approximately 50% of European adolescents fail to consume fruit and vegetables daily and respectively 25% and 15% consume sweets and soft drink regularly (Beal et al., 2019; Inchley et al., 2020). Additionally, national and international reports have identified

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https://doi.org/10.1016/j.appet.2024.107339
Received 12 October 2023; Received in revised form 25 March 2024; Accepted 3 April 2024
Available online 10 April 2024

socioeconomic inequalities in adolescent dietary behaviours (Chatelan et al., 2021; Desbouys et al., 2020; Inchley et al., 2020) and diet-related diseases such as obesity (Chung et al., 2016). These studies have established that – in most European countries – adolescents with a lower socioeconomic status (SES) have less favourable diets (e.g., lower fruit and vegetable intake, higher sweets and soft drink consumption) compared to their higher SES counterparts. Furthermore, there are cross-national variations in the size of these socioeconomic inequalities (Moor et al., 2014; Vereecken, Inchley, et al., 2005).

Research to date has generally focused on country-level socioeconomic factors to explain this cross-national variation. Findings have indicated that socioeconomic inequalities are greatest in countries with high levels of income inequality (Elgar et al., 2015). However, there is growing recognition that socioeconomic inequalities not only vary by different country-level *socioeconomic contexts* but also according to variations in *sociocultural contexts* (Kagawa Singer, 2012; Mansyur et al., 2009). Extending current understandings of cross-national differences in adolescent health inequalities requires inclusion of country-level sociocultural factors in cross-national adolescent inequality research.

Drawing upon research traditions from the field of cultural psychology, *cultural values* may be relevant examples of sociocultural factors. Cultural values are shared societal preferences concerning appropriate courses of action that guide norms and behaviour and determine what is important within society (Nolan & Lenski, 2004). Stemming from Schwartz' cultural values theory, one such important measure of cultural values is *openness-to-change* (Schwartz, 2012). Openness-to-change combines several basic values – self-direction, stimulation and hedonism – proposed to be at the base of human needs (Schwartz, 2012). Holding such values may indicate a tendency to invest in personal wellbeing and health, perhaps through adopting healthy behaviour (Mackenbach, 2014). A culture where openness-to-change values are largely shared by young and old may point to a collective climate of health investment. Openness-to-change values are typically endorsed in open and trusting societies (Inglehart & Welzel, 2009) where social cohesion is strong and social boundaries are less strict. Such collective health investments may support all adolescents, including those from lower SES groups. Through positive spillover effects, adolescents from lower SES groups in such countries may benefit from favourable health actions of connections in their social network and access resources beneficial to their health, thus mitigating socioeconomic inequalities.

Despite available cross-national sociocultural data (e.g., World Values Survey, European Social Survey), comparative research on the impact of country-level sociocultural contexts is scarce, limited to adult populations and solely focused on health or health behaviours but not on socioeconomic inequalities in health (behaviours) (Mackenbach, 2014; Roudijk et al., 2017). We are aware of only one cross-national study that has examined how country-level sociocultural contexts are associated with differences in adolescent socioeconomic inequalities in health (Weinberg et al., 2020). This study observed that meritocratic beliefs moderated the association between SES and adolescent mental health, strengthening the social gradient for family affluence and weakening it for perceived family wealth. When it comes to inequalities in health behaviours and particular within the field of dietary health, there are no studies available. Besides, previous studies including country-level socioeconomic contexts (and by extension sociocultural contexts) did not evaluate how the magnitude of socioeconomic inequalities may be associated with changes within country-level sociocultural contexts over time (Elgar et al., 2015; Weinberg et al., 2020). Accordingly, they were unable to assess how time-varying contexts at country-level are associated with socioeconomic inequalities over time. Yet, information on time-varying sociocultural effects on socioeconomic inequalities could generate further insights in addition to cross-sectional observations, but this is often overlooked in analyses with repeated cross-sectional data (Fairbrother, 2014).

Using comparable cross-national data from 21 countries spanning twelve years, we aimed to bridge this knowledge gap by addressing two questions. First, whether variation in sociocultural context (i.e., openness-to-change) at country-level was associated with differences in socioeconomic inequalities in dietary behaviours, independent from the country-level socioeconomic context (e.g., national income, national income inequality). Second, whether changes in country-level sociocultural context were associated with inequalities over time, independent from changes in the country-level socioeconomic context. Based on theoretical assumptions, we expected higher levels of openness-to-change at country-level and increases thereof over time, to be associated with smaller socioeconomic inequalities in adolescent dietary behaviours. Since different SES indicators provide distinct but complementary information (Pfortner et al., 2015), we used two SES indicators: family affluence, representing material resources of SES (Currie et al., 2008) and parental occupational social class, serving as an indicator of non-material resources (Dierckens et al., 2022).

2. Methods

This study includes three sources of repeated cross-sectional data: (1) individual-level data from the Health Behaviour in School-aged Children (HBSC) survey, (2) country-level data on openness-to-change aggregated from the European Social Survey (ESS (European Social Survey, 2018)) and (3) country-level data on national income (GNI (World Bank Databank, 2019)) and income inequality (GINI (Solt, 2019)) from open access databases.

2.1. Individual-level data: HBSC survey

2.1.1. Study participants and procedure

Individual-level data on dietary behaviours and SES came from the cross-national HBSC survey, which is conducted every four years in a growing sample of countries (Currie et al., 2014). Our study included data from 21 European countries, participating in four successive waves in 2002, 2006, 2010 and 2014. Each country used cluster probability sampling with classes within schools as initial sampling units ensuring a nationally representative sample of 11-, 13- and 15-year-old participants (Currie et al., 2014). Data were collected using a standardised and validated self-completion questionnaire administered in classrooms during school time. Participation was anonymous and voluntary, following country-specific consent guidelines. Ethical or equivalent approval was granted in each country. The present study was approved by the Ethics Committee of the University Hospital of Ghent (EC 2019/0755).

2.1.2. Measures

Dietary behaviours. Adolescents' dietary behaviours were measured using the HBSC short food frequency questionnaire (sFFQ) and assessed the consumption frequency of *fruit*, *vegetable*, *sweets* and *sugar-sweetened soft drink* (Vereecken et al., 2015). Response options varied on a seven-point response scale from *'never = 1'* to *'more than once a day = 7'*. To align with healthy diet recommendations, responses were dichotomised, considering *'once a day'* and *'more than once a day'* as daily consumption (coded one) and all other response options as zero. Following this dichotomisation, 'daily fruit and/or vegetable consumption' was considered a healthy dietary behaviour, while 'daily sweets and/or sugar-sweetened soft drink consumption' was considered unhealthy (Vereecken et al., 2015).

Socioeconomic status. SES was measured using two independent, but complementary indicators: family affluence and parental occupational social class. The *Family Affluence Scale II* (FAS) is a composite measure capturing families' material assets based on four items (family car, own bedroom, family holiday and family computer) from which the absolute affluence score was calculated, ranging from zero (lowest affluence) to nine (highest affluence) (Currie et al., 2008). The FAS has proven to be a valid instrument with generally low missing data compared to other SES

indicators (Torsheim et al., 2016). Parental *occupational social class* (OSC) was measured by asking adolescents about their parents' employment status followed by two open-ended questions on workplace and job function and a third option to specify the reason for non-employment in case of non-working parent(s). Responses were categorised based on the classical Registrar General Social Class coding (Macintyre et al., 2003), ranking parental OSC from one (lowest OSC) to five (highest OSC). To minimise missing data, data from only the parent with the highest OSC was used. Parental OSC has demonstrated good agreement between adolescent and parental reports of occupation (Lien et al., 2001) and is considered a valid proxy indicator in adolescent research that measures other aspects of SES than material assets (Pfortner et al., 2015).

To facilitate comparisons across countries and time-varying socioeconomic contexts, the absolute FAS and OSC scores were transformed to continuous indices through ridit transformation (Elgar et al., 2017). This resulted in FAS- and OSC-values ranging from zero to one with a mean of 0.50 per country and survey year, thus measuring adolescents' SES relative to place and time. When included in regression models, the coefficient reflects the absolute difference in eating behaviours between highest (one) and lowest (zero) affluence and occupational social class groups.

2.2. Country-level data: ESS

2.2.1. Study participants and procedure

Data on cultural values came from ESS round one (2002), three (2006), five (2010) and seven (2014). ESS is a large repeated cross-sectional survey on attitudes, beliefs and behaviour patterns in nationally representative samples of respondents aged 15 and older and is conducted every two years in over 30 countries. The recommended sample size per country is set at 1500 respondents (800 in countries with <2 million inhabitants) (European Social Survey, 2018).

2.2.2. Measures

Openness-to-change is calculated by the mean of six items according with three basic values: self-direction ('*think up new ideas/be creative*' and '*make own decisions*'), stimulation ('*like surprises/look for new things to do*' and '*look for adventures, like risks*') and hedonism ('*have a good time*' and '*have fun*'). For each item, respondents were asked to rate their agreement with the statement using a six-point response scale ranging from '*very much like me = 1*' to '*not like me at all = 6*'. Scores were reverse coded to ease interpretation with higher scores signifying a higher openness-to-change (Schwartz, 2012). By aggregating individual-level scores on *openness-to-change,* each country's cultural values orientation was assessed (Schwartz, 2012). Calculation of the intraclass correlation coefficient justified this aggregation (Shrout & Fleiss, 1979).

2.3. Country-level data: national income and income inequality

The country socioeconomic context was measured by including national income and income inequality data for every country and HBSC survey year. Data on gross national income came from the World Bank Databank and were converted to U.S. dollars (US$) using the Atlas Method to allow cross-national comparisons (World Bank Databank, 2019). Income inequality data were obtained from version 8.2 of the Standardised World Income Inequality Database (Solt, 2019). Income inequality ranges from zero (perfect income equality) to one hundred (perfect income inequality).

2.4. Statistical analysis

Data from 21 countries participating across four HBSC survey waves and with country-level data on cultural values, were included. Missing data on cultural values for a given round were substituted with data from the adjacent ESS round or the mean score from two adjacent ESS rounds. No appropriate substitute data were available for Croatia (2002 and 2014), Italy and Russia (2002) and Greece (2014) and these were omitted from analysis for that given year. Only individuals with complete data were kept. Proportions of missing data varied from 0.7% for age to 18.3% for OSC. The final sample comprised 344,352 adolescents from 21 countries and 79 country-period groups.

Multilevel regression analyses were performed, accounting for the hierarchical data structure with adolescents (i) within schools (j), within country-survey years (k), within countries (l). The country-level of openness-to-change (X_{kl}) was decomposed into the between-country-level effect by calculating country-level means of openness-to-change across all survey years for each country ($\overline{X}_l$) (Fairbrother, 2014). The within-country effect was obtained by subtracting this mean from country-level observations of openness-to-change over the four survey years ($X_{kl} - \overline{X}_l$). Hence, by group-mean centring, the within-country effect was uncorrelated and orthogonal to the between-country effect and both terms could simultaneously be included in the regression model to separately estimate variation between countries and within countries over time. A similar specification was used for the country-level economic variables (national income and income inequality).

For each dependent variable, our analysis proceeded in two steps. First, an intercept-only model to examine the variability at school-, country-period and country-level was run (Models 0). Second, cross-level interactions were added between country-levels and country-period levels of openness-to-change and FAS (Models 1a) and OSC (Models 1b), respectively to assess differences in socioeconomic inequalities in dietary behaviours between countries with distinct levels of openness-to-change and within countries over time. These models were controlled for individual-level covariates (sex, age, sex-by-age interaction) and country-level socioeconomic contexts (national income and national income inequality). Random slope terms for FAS and OSC at country and country-period levels were included and a linear time variable was added to capture common time trends. Multilevel logistic regression models were estimated in R version 3.6.2 using *lme4*-package (Bates et al., 2015) with statistical significance set at alpha 0.05. All continuous individual- and country-level (i.e., cross-sectional or between effect) independent variables were grand mean centred. To aid interpretation of significant cross-level interactions, adjusted predictions were calculated and plotted using *ggeffects*-package (ggeffects, 2018).

3. Results

3.1. Descriptive results

Table 1 shows individual-level and country-level characteristics per survey year and for the total sample using original variables scales. Table 2 and Appendix A present country-level and country-period level characteristics. Country levels of openness-to-change ranged from 33.33 (Ukraine, 2002) to 44.55 (Slovenia, 2014), national income per capita ranged from US$ 790 (Ukraine, 2002) to US$ 104,540 (Norway, 2014) and income inequality ranged from 22.90 (Denmark, 2002) to 37.00 (Russia, 2006). Changes in national income, although different in size, were positive for all countries from 2010 onwards, indicating an increase in national income. For openness-to-change and income inequality, increases and decreases were spread across countries and survey years and no clear pattern could be observed. Correlations between individual-level and country-level measures are available in Appendix B (Tables B1 and B2).

3.2. Four-level multilevel logistic regression results

For all outcomes, most variance was either found at school-level or country-level, with less variation observed at country-period level (i.e.,

Table 1
Individual-level and country-level sample characteristics per survey year and for the total sample.

	2002 (n = 78,093)	2006 (n = 96,679)	2010 (n = 96,941)	2014 (n = 72,639)	Total (n = 344,352)
Individual characteristics					
Sex, n (%)					
Boy	37,945 (48.6%)	46,678 (48.3%)	46,578 (48.0%)	34,500 (47.5%)	165,701 (48.1%)
Girl	40,148 (51.4%)	50,001 (51.7%)	50,363 (52.0%)	38,139 (52.5%)	178,651 (51.9%)
Age (years)	13.50 (1.67)	13.63 (1.66)	13.58 (1.66)	13.81 (1.61)	13.62 (1.65)
Socioeconomic indicators					
Material affluence (FAS)[a]	5.09 (1.89)	5.35 (1.92)	5.96 (1.86)	5.98 (1.91)	5.59 (1.93)
Occupational social class (OSC)[b]	2.96 (1.13)	2.89 (1.19)	3.06 (1.17)	3.20 (1.26)	3.02 (1.19)
Health behaviours, n (%)					
Fruit (at least daily)	25,430 (32.6%)	34,113 (35.3%)	35,017 (36.1%)	25,858 (35.6%)	120,418 (35.0%)
Vegetable (at least daily)	24,119 (30.9%)	31,410 (32.5%)	32,292 (33.3%)	26,739 (36.8%)	114,560 (33.3%)
Sweets (at least daily)	21,246 (27.2%)	24,955 (25.8%)	22,118 (22.8%)	15,370 (21.2%)	83,689 (24.3%)
Soft drink (at least daily)	20,828 (26.7%)	21,907 (22.7%)	18,555 (19.1%)	10,908 (15.0%)	72,198 (21.0%)
Country characteristics					
Openness-to-change[c]	40.27 (2.31)[d]	39.98 (2.14)	40.46 (2.30)	40.56 (2.06)[e]	40.31 (2.22)
Gross national income (GNI),US$	19,764 (10,434)	31,807 (17,361)	36,335 (19,229)	39,152 (21,008)	31,900 (18,882)
Income inequality (GINI)[c]	28.28 (3.53)	29.09 (3.73)	28.93 (3.49)	29.01 (3.57)	28.85 (3.60)

Note. Data are mean (standard deviation) unless otherwise indicated. n = sample size; FAS = family affluence scale; OSC = occupational social class.
[a] scale: 0–9.
[b] scale: 1–5.
[c] scale: 0–100.
[d] no appropriate substitute data were available for Croatia, Italy and Russia.
[e] no appropriate substitute data were available for Croatia and Greece.

within countries over time; Table 3). For example, the variance partition coefficient (VPC) for fruit consumption indicated that roughly 4%, 1% and 1% of the total variance was attributable to the school, country and country-period level respectively. Results of cross-level interactions examining the moderating role of country-level of openness-to-change in the association between FAS/OSC and dietary behaviours are detailed below.

3.2.1. *Differences in socioeconomic inequalities in dietary behaviours according to variations between country-level sociocultural context*

FAS inequalities in fruit, sweets and soft drink, but not vegetable consumption differed between countries according to country-level of openness-to-change (Table 4, Models 1a). In countries with a higher level of openness-to-change, differences in fruit (Fig. 1a), sweets (Fig. 1b) and soft drink consumption (Fig. 1c) were smaller between lowest and highest FAS groups, implying smaller FAS inequalities. Conversely, country-level of openness-to-change was associated with differences in OSC inequalities in soft drink consumption only (Table 4, Models 1b), but not in fruit, vegetable or sweets consumption. In countries with a higher level of openness-to-change, differences in soft drink consumption were larger between higher and lower OSC groups, denoting larger OSC inequalities there, compared to lower openness-to-change countries (Fig. 1d).

3.2.2. *Differences in socioeconomic inequalities in dietary behaviours according to variations within country-level sociocultural context over time*

Changes within-country openness-to-change over time were not associated with FAS inequalities in any of the dietary behaviours. Similar null findings for OSC inequalities in adolescents' dietary behaviours were observed (Table 4, Models 1a – 1b).

4. Discussion

Numerous studies have focused on national income and income inequality as country-level moderators of socioeconomic inequalities in adolescent health. Our study extends this research in several ways. First, we included the sociocultural context as well, finding that *a country's level of openness-to-change* was generally associated with differences in socioeconomic inequalities in adolescent dietary behaviours, independently from country-level income and income inequality. In countries where the public is more open to change, *smaller* FAS inequalities in fruit, sweets and soft drink but not vegetable consumption were observed, whereas in these countries *larger* OSC inequalities in soft drink consumption were found (with no differences for the other three dietary behaviours). Second, unlike prior studies, our research studied changes *within countries over time,* thereby examining the potential role of time-varying sociocultural effects on socioeconomic inequalities apart from cross-sectional observations. However, within-country openness-to-change over time was not associated with adolescent dietary inequalities. Third, unlike most other studies, we distinguished between *different SES indicators* and included both FAS and OSC. Associations between country-level openness-to-change were stronger when inequalities were measured using FAS than OSC and the two SES indicators returned contrasting results. The higher the openness-to-change at the country-level, the *smaller* FAS inequalities and the *larger* OSC inequalities.

As expected, FAS inequalities in dietary behaviours were smaller in countries with openness-to-change as the dominant value system. This seems to support the idea that in countries with more openness-to-change, an emphasis on self-direction and autonomy is related to a tendency – shared among both adolescents and adults – to foster and collectively invest in good health (Mackenbach, 2014). It is plausible that countries highly valuing openness-to-change display more openness, social engagement and stronger social cohesion (Inglehart & Welzel, 2009), thereby potentially channelling collective health investments towards lower SES groups, providing access to resources beneficial to their health and mitigating socioeconomic inequalities. Country-level openness-to-change did not moderate the association between FAS and vegetable consumption. This suggests that the variety in FAS inequalities across countries cannot be explained by one national-level process.

Unexpectedly, OSC inequalities in most dietary behaviours were not associated with country-levels of openness-to-change. Intriguingly, for soft drink consumption, inequalities were larger in countries with higher levels of openness-to-change. This could stem from an effect of openness-to-change on public health policies. As dominant value orientations may be reflected in political regimes (Hofstede, 2001), a disposition towards openness-to-change might translate into inclusive public health policy supported by financial redistribution. Additionally, openness-to-change may foster political participation (e.g., voting

Table 2
Descriptive characteristics on country-level and country-period variables per country and survey year.

	Openness-to-change					GNI					GINI				
Country	Mean ($\bar{X}$)	2002 - $\bar{X}$	2006 - $\bar{X}$	2010 - $\bar{X}$	2014 - $\bar{X}$	Mean ($\bar{X}$)	2002 - $\bar{X}$	2006 - $\bar{X}$	2010 - $\bar{X}$	2014 - $\bar{X}$	Mean ($\bar{X}$)	2002 - ($\bar{X}$)	2006 - $\bar{X}$	2010 - $\bar{X}$	2014 - $\bar{X}$
Austria	42.06	−0.55	0.37	−0.02	0.21	41.36	−16.39	0.10	8.25	9.01	27.46	−0.66	−0.56	0.54	0.14
Belgium	42.30	0.28	−0.18	−0.36	0.15	39.15	−15.02	0.88	8.77	7.77	25.59	0.61	0.01	−0.29	−0.39
Croatia[a,b]	36.93		0.38	−0.30		11.52		−0.21	2.67		27.35		−0.95	0.35	
Denmark	42.40	0.26	−0.95	0.25	0.82	51.75	−20.90	1.79	9.47	11.92	24.17	−1.37	−0.27	0.53	1.43
Estonia	38.13	−1.24	−0.32	1.85	−0.36	12.43	−7.81	−0.93	2.11	6.48	33.28	1.22	−0.18	−0.98	0.02
Finland	40.42	−0.17	−0.70	0.31	0.42	42.25	−16.74	0.49	7.08	6.74	25.26	−0.46	0.34	0.14	−0.06
France	40.44	1.13	−0.72	−0.37	−0.31	35.91	−12.82	1.94	7.94	7.41	28.62	−0.82	−0.52	0.68	1.08
Greece[b]	42.92	−0.15	0.44	−0.22		22.27	−9.12	2.28	5.39		33.10	−0.00	−0.30	−0.10	
Hungary	42.86	−0.74	−0.43	0.85	0.12	10.89	−5.56	0.46	2.28	2.65	27.31	0.19	−0.21	−0.31	0.39
Ireland	40.33	−0.50	−0.50	0.61	0.21	42.72	−17.89	5.19	2.15	3.73	30.00	0.50	−0.10	−0.20	0.00
Italy[a]	40.03		0.72	1.08	−1.99	31.86		2.35	5.83	2.90	33.02		−0.32	−0.12	0.48
Netherlands	42.11	−0.66	0.30	0.39	−0.07	44.89	−17.87	1.02	9.01	7.09	26.22	−0.62	0.38	−0.32	0.58
Norway	38.56	−0.92	−0.34	0.55	1.11	72.71	−32.81	−2.73	15.85	31.83	24.99	0.41	0.01	−0.59	0.11
Poland	38.09	0.02	0.34	−0.00	−0.44	9.38	−4.49	−0.92	3.35	4.26	30.55	−0.75	0.95	0.25	−0.35
Portugal	38.49	0.20	−1.00	−0.01	0.68	19.45	−7.72	−0.12	3.51	1.81	33.80	0.10	0.40	−0.20	−0.20
Russia[a]	38.25		−1.08	1.16	0.62	7.09		−1.28	2.89	7.56	36.03		0.97	−0.53	−1.93
Slovenia	43.66	−1.44	−0.31	0.53	0.89	20.28	−9.33	−0.41	4.18	3.25	24.31	−1.01	−0.51	0.39	0.89
Spain	40.49	0.13	−0.33	0.23	0.09	26.79	−11.21	1.18	5.34	2.51	32.21	−2.31	−0.91	0.99	1.49
Sweden	40.57	−1.59	−0.79	0.24	1.05	50.99	−22.18	−2.17	2.88	10.05	24.95	−0.95	−0.65	0.25	0.65
Ukraine	34.59	−1.26	0.17	−0.54	1.64	2.39	−1.60	−0.44	0.59	1.17	27.93	1.37	0.57	−0.63	−1.03
United Kingdom	40.12	0.04	0.12	0.03	−0.19	40.49	−11.41	4.41	0.79	3.45	33.30	0.40	0.20	0.00	−0.50

Note. GNI = gross national income; GINI = income inequality.
[a] No appropriate substitute data were available for Croatia, Italy and Russia.
[b] No appropriate substitute data were available for Croatia and Greece.

Table 3
Variance partition coefficient (VPC) of the intercept-only models.

	Fruit		Vegetable		Sweets		Soft drink	
	Variance	VPC (%)	Variance	VPC (%)	Variance	VPC (%)	Variance	VPC (%)
Country-level[a]	0.037	1.06	0.197	5.33	0.583	14.20	0.440	10.44
Country-period level[b]	0.042	1.19	0.048	1.30	0.095	2.31	0.210	4.98
School-level[c]	0.137	3.91	0.162	4.38	0.139	3.38	0.273	6.48
Residual		93.84		88.99		80.11		78.09

Note.
[a] Proportion of unexplained variance at country-level = $\sigma^2_{\text{country}}/(\sigma^2_{\text{country}} + \sigma^2_{\text{country-period}} + \sigma^2_{\text{school}} + \pi^2/3)$.
[b] Proportion of unexplained variance at country-period level = $(\sigma^2_{\text{country-period}})/(\sigma^2_{\text{country}} + \sigma^2_{\text{country-period}} + \sigma^2_{\text{school}} + \pi^2/3)$.
[c] Proportion of unexplained variance at school-level = $(\sigma^2_{\text{school}})/(\sigma^2_{\text{country}} + \sigma^2_{\text{country-period}} + \sigma^2_{\text{school}} + \pi^2/3)$.

(Inglehart & Welzel, 2009; Reeves & Mackenbach, 2019)), reinforcing these public health policies. Considering that OSC embodies a *non-material component* of SES (e.g., incorporated cultural resources that are indispensable for healthy lifestyle choices such as dietary behaviours (Bourdieu and Richardson, 1986; Dierckens et al., 2022)), it is likely that OSC inequalities in dietary behaviours remain largely untouched by social policies that primarily focus on redistributing *material resources*. That FAS inequalities – indicative of material resources – in dietary behaviours were indeed smaller in countries with higher levels of openness-to-change, lends support of this assumption. Furthermore, when non-material aspects of SES, such as cultural health capital, serve as the central mechanism driving health inequalities (Mackenbach, 2019), health behaviours may emerge as products of socialisation processes and tend to become ingrained within adolescents routines. Consequently, they are much harder to be influenced by macro-level processes.

Despite variations between sociocultural contexts were generally associated with the magnitude of socioeconomic inequalities in dietary behaviours, this association could not be confirmed *within countries over time*. It is possible that over a twelve-year timeframe, no considerable changes in countries' sociocultural contexts took place or that changes were too small to have an impact on dietary inequalities. Indeed, variations in country-level openness-to-change within countries were relatively small. Further research should therefore consider a longer timeframe since changes in values may be small and gradual and their impact may be lagged (Dobewall & Aavik, 2016; Inglehart & Welzel, 2009).

4.1. Strengths and limitations

Our study findings have certain limitations. First, our sample included data from 21 (high income) European countries only. The small sample size at higher level unit could have introduced potential bias in the estimates. Relatedly, missing data on openness-to-change for some survey years in four countries led to less variability over time within these countries. Yet, for almost all countries surveyed we had data on all four data points ($N_{\text{country-period}} = 79$). Second, due to data availability, we considered four food groups only, offering a rather crude indication of adolescent dietary behaviours. Future research could benefit from a more comprehensive examination of dietary behaviours, including a broader range of food groups such as for example the consumption of whole grains, protein sources and sustainable foods to capture the complexity of adolescent dietary behaviours and socioeconomic inequalities thereof more accurately. Nevertheless, the selected food groups are considered to be important dietary indicators that are associated with adolescents' health status and obesity risk (Vereecken, De

Table 4
Multilevel logistic regression models of socioeconomic inequalities in the probability of daily fruit, vegetable, sweet and soft drink consumption and its association with country-level effects, $N_{individuals} = 344{,}352$; $N_{schools} = 16{,}880$; $N_{country\text{-}periods} = 79$; $N_{countries} = 21$.

	Material affluence (FAS) – Models 1a				Occupational social class (OSC) – Models 1b			
	Fruit	Vegetable	Sweets	Soft drink	Fruit	Vegetable	Sweets	Soft drink
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Individual								
Intercept	0.42 (0.36, 0.50)***	0.32 (0.26, 0.41)***	0.32 (0.23, 0.44)***	0.48 (0.33, 0.70)***	0.44 (0.37, 0.51)***	0.32 (0.25, 0.40)***	0.32 (0.23, 0.44)***	0.43 (0.29, 0.62)***
FAS	1.70 (1.61, 1.80)***	1.53 (1.46, 1.61)***	1.13 (1.04, 1.22)**	1.18 (1.07, 1.30)***	1.70 (1.65, 1.75)***	1.56 (1.52, 1.60)***	1.16 (1.13, 1.20)***	1.13 (1.10, 1.17)***
OSC	1.38 (1.34, 1.42)***	1.62 (1.58, 1.67)***	0.82 (0.79, 0.84)***	0.50 (0.48, 0.52)***	1.34 (1.27, 1.42)***	1.55 (1.43, 1.68)***	0.77 (0.68, 0.87)***	0.50 (0.45, 0.55)***
Country-period								
Openness	1.03 (0.97, 1.10)	1.01 (0.96, 1.08)	0.97 (0.90, 1.04)	0.98 (0.88, 1.09)	1.03 (0.97, 1.10)	1.01 (0.95, 1.07)	0.97 (0.90, 1.03)	0.97 (0.87, 1.08)
GNI	1.01 (1.00, 1.01)*	1.01 (1.00, 1.02)*	0.99 (0.98, 1.00)**	1.00 (0.98, 1.01)	1.01 (1.00, 1.01)*	1.01 (1.00, 1.01)*	0.99 (0.98, 1.00)**	0.99 (0.98, 1.00)
GINI	0.93 (0.88, 0.98)**	1.01 (0.96, 1.07)	0.95 (0.89, 1.01)	1.04 (0.94, 1.16)	0.93 (0.88, 0.98)*	1.01 (0.96, 1.07)	0.94 (0.88, 1.00)*	1.04 (0.94, 1.15)
Openness × SES[a]	0.96 (0.91, 1.01)	0.98 (0.93, 1.03)	0.98 (0.92, 1.05)	0.94 (0.85, 1.03)	0.95 (0.90, 1.00)	1.00 (0.96, 1.05)	1.03 (0.96, 1.10)	0.94 (0.86, 1.02)
GNI × SES[a]	1.00 (1.00, 1.01)	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)	0.99 (0.99, 1.00)	1.01 (1.00, 1.01)*	1.01 (1.00, 1.01)*	1.00 (0.99, 1.00)	0.99 (0.98, 0.99)***
GINI × SES[a]	1.01 (0.97, 1.06)	0.99 (0.94, 1.04)	1.07 (1.01, 1.14)*	1.14 (1.05, 1.25)**	1.03 (0.98, 1.08)	0.99 (0.95, 1.04)	1.05 (0.99, 1.12)	1.00 (0.92, 1.08)
Country								
Openness	1.01 (0.97, 1.06)	0.96 (0.88, 1.05)	1.01 (0.89, 1.16)	1.07 (0.93, 1.23)	1.01 (0.97, 1.06)	0.96 (0.87, 1.05)	1.01 (0.89, 1.16)	1.07 (0.93, 1.23)
GNI	1.00 (0.99, 1.01)	1.00 (0.99, 1.02)	0.98 (0.96, 1.00)*	0.99 (0.97, 1.00)	1.00 (0.99, 1.01)	1.00 (0.99, 1.02)	0.98 (0.96, 1.00)	0.99 (0.67, 1.00)
GINI	1.01 (0.98, 1.04)	0.97 (0.91, 1.03)	1.04 (0.95, 1.14)	1.02 (0.93, 1.12)	1.01 (0.98, 1.04)	0.97 (0.91, 1.02)	1.04 (0.93, 1.04)	1.02 (0.93, 1.11)
Openness × SES[a]	0.95 (0.92, 0.98)***	1.01 (0.99, 1.04)	0.93 (0.90, 0.97)***	0.94 (0.90, 0.98)**	0.99 (0.97, 1.02)	1.02 (0.98, 1.06)	0.98 (0.93, 1.04)	0.94 (0.90, 0.99)*
GNI × SES[a]	0.99 (0.98, 1.00)***	1.00 (1.00, 1.00)	0.99 (0.99, 1.00)*	0.99 (0.98, 0.99)***	1.01 (1.00, 1.01)**	1.01 (1.01, 1.02)***	0.99 (0.98, 1.00)*	0.99 (0.98, 1.00)**
GINI × SES[a]	1.01 (0.99, 1.02)	1.02 (1.00, 1.03)*	0.98 (0.95, 1.00)	0.97 (0.94, 1.00)*	1.02 (1.00, 1.04)	1.02 (0.99, 1.04)	0.99 (0.95, 1.02)	0.99 (0.96, 1.02)
Variance (95% CI)								
Country								
Intercept	0.041 (0.03; 0.08)	0.180 (0.11; 0.33)	0.397 (0.25; 0.73)	0.400 (0.25; 0.74)	0.040 (0.03; 0.07)	0.180 (0.11; 0.33)	0.403 (0.26; 0.74)	0.402 (0.26; 0.74)
Slope	0.012 (0.01; 0.01)	0.006 (0.00; 0.01)	0.024 (0.02; 0.04)	0.031 (0.02; 0.06)	0.012 (0.01; 0.02)	0.031 (0.02; 0.06)	0.057 (0.04; 0.10)	0.035 (0.02; 0.07)
Country-period								
Intercept	0.027 (0.02; 0.04)	0.025 (0.02; 0.03)	0.035 (0.03; 0.05)	0.089 (0.07; 0.12)	0.027 (0.02; 0.04)	0.025 (0.02; 0.03)	0.035 (0.03; 0.05)	0.088 (0.07; 0.12)
Slope	0.005 (0.02; 0.04)	0.007 (0.02; 0.03)	0.014 (0.03; 0.05)	0.046 (0.07; 0.12)	0.008 (0.02; 0.04)	0.002 (0.02; 0.03)	0.018 (0.03; 0.05)	0.028 (0.07; 0.12)
School								
Intercept	0.09 (0.09; 0.09)	0.133 (0.13; 0.14)	0.130 (0.13; 0.13)	0.218 (0.21; 0.22)	0.09 (0.09; 0.09)	0.127 (0.12; 0.13)	0.129 (0.13; 0.13)	0.216 (0.21; 0.22)
Log Likelihood	−215,497	−205 711	−176,943	−160,258	−215,586	−205 506	−176,960	−160,367
AIC	431,047	411,474	353,938	320,567	431,223	411,065	353,963	320,785
BIC	431,326	411,753	354,217	320,847	431,503	411,344	354,200	321,065

Note. Data are odds ratios (OR), 95% confidence intervals (CI) and p-values. *p < 0.05, **p < 0.01, ***p < 0.001. FAS = family affluence scale; OSC = occupational social class; SES = socioeconomic status; GNI = gross national income; GINI = income inequality; AIC = Akaike information criterion; BIC = Bayesian information criterion; SD = standard deviation.

[a] Two indicators of SES were used: FAS (results presented in the left part of the table; Models 1a) and OSC (results presented in the right part of the table; Models 1b). Models were controlled for age, sex, and sex-by-age interaction.

Henauw, & Maes, 2005). Third, adolescents' reports on OSC showed a high level of missingness compared to FAS and the outcome measures. Although previous studies established good agreement between adolescent and parental OSC reports (Lien et al., 2001), not all respondents were able to give a complete account of their parental occupation, precluding categorisation into one of the OSC categories. Furthermore, adolescents with economically inactive parents were excluded due to uncertainties about reasons for unemployment (e.g., student, ill, retired, job seeker, stay at home parent). This may have resulted in an underestimation of OSC inequalities in adolescent dietary behaviours. Fourth, the cross-sectional nature of the HBSC survey may cast some doubt on the direction of causality. While SES likely influences dietary behaviours, selection effects (e.g., parental unhealthy dietary behaviours lead to ill health and economic inactivity and there is a strong association between parental and adolescents' unhealthy dietary behaviours) or unknown confounders might be at play too (Mackenbach, 2019).

Despite these limitations, the main strength of our study is that we combined international comparative data from 21 European countries at different time points with aggregated data from the ESS and macro-economic data sources. We were – to the best of our knowledge – the first to simultaneously analyse sociocultural variation both between

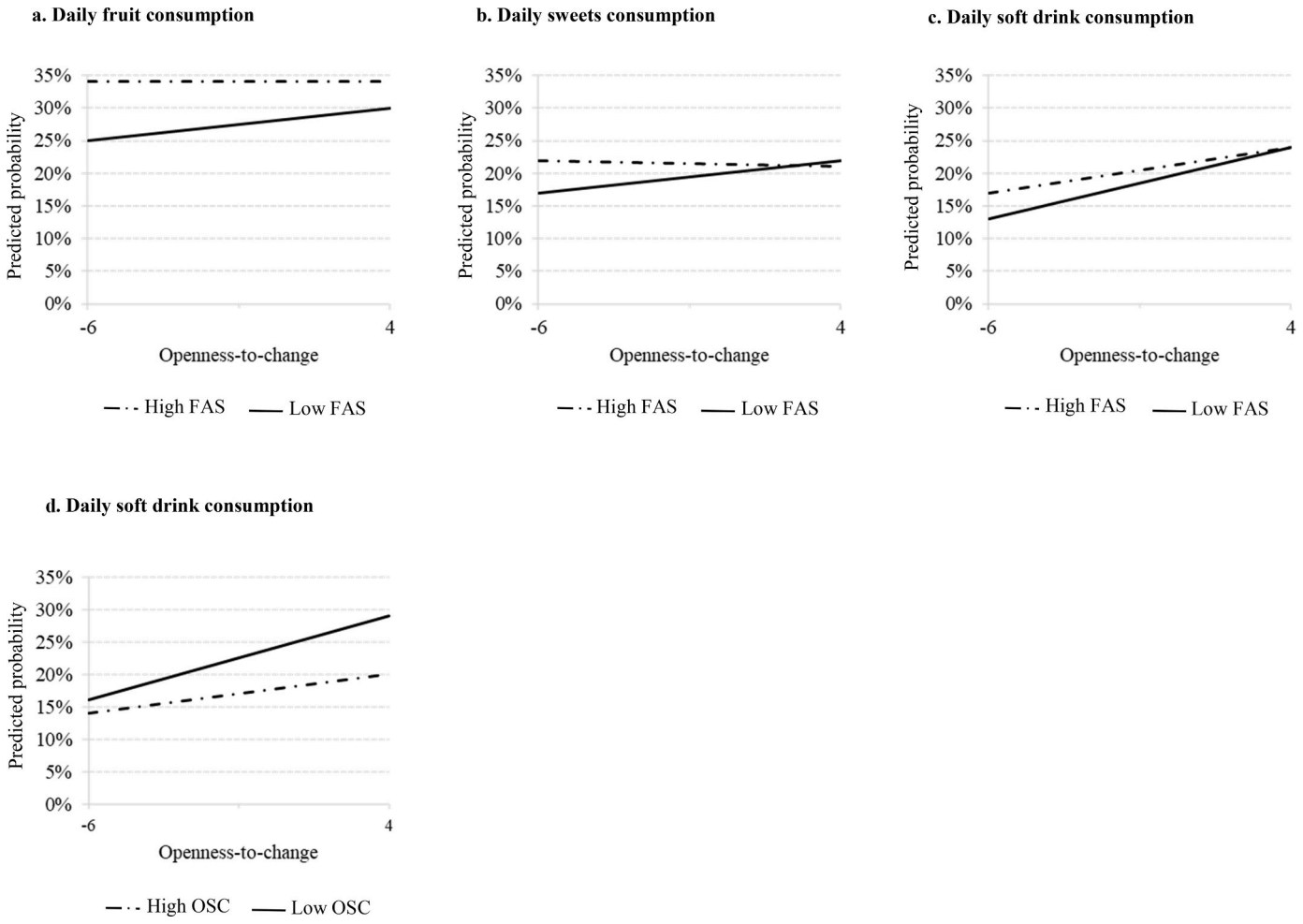

Fig. 1. Between-country differences in FAS inequalities in daily fruit, sweets and soft drink consumption (a–c) and in OSC inequalities in daily soft drink consumption (d) in association with openness-to-change.
Note. FAS = family affluence scale; OSC = occupational social class. Openness-to-change was centred, negative and positive values on the x-axis indicate respectively low and high levels of openness-to-change.

countries and within countries over time in relation to adolescent dietary inequalities, independent from country-level socioeconomic contexts. As such, we have shown that adolescent dietary inequalities may depend on variations in country-level sociocultural contexts. In addition, the parallel use of two independent but complementary SES indicators (of which FAS was specifically designed for adolescent populations) (Currie et al., 2008) provided a more comprehensive understanding of adolescents' dietary inequalities.

4.2. Conclusion

Extending previous work on cross-national differences in socioeconomic inequalities in adolescent health and health behaviours, this study provides a new understanding by also considering the country-level sociocultural context and changes thereof and by including different SES indicators. Country-level openness-to-change moderated socioeconomic inequalities in adolescent dietary behaviours, net of countries' socioeconomic contexts. Higher country-levels of openness-to-change were associated with smaller FAS inequalities but with larger OSC inequalities in dietary behaviours. However, these associations were stronger when inequalities were measured using FAS than OSC. Variations within openness-to-change over time were not associated with dietary inequalities. Our study opens new perspectives for future research and public health initiatives aimed at tackling socioeconomic inequalities. Our results indicate that sociocultural contexts need to be considered in cross-national research to gain a better understanding of the complex linkage between SES and adolescent dietary health. Further research should be undertaken to test the mechanisms that were proposed in this paper and could consider a broader range of food groups to more accurately capture the complexity of social inequalities in adolescent dietary behaviours. To develop a fuller understanding, future studies are advised to consider a longer timeframe to examine whether the observed association of variations between sociocultural contexts and adolescent dietary inequalities also occurs within countries over time.

Funding sources

This work was supported by the government of Flanders. The Health Behaviour in School-aged Children survey is funded by public sources in each member country.

Ethical statement

The present study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the University Hospital of Ghent (EC 2019/0755).

CRediT authorship contribution statement

Maxim Dierckens: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Benedicte Deforche:** Funding acquisition, Supervision, Writing – review & editing. **Bart De Clercq:** Conceptualization, Writing – review & editing. **Dominic Weinberg:** Writing – review & editing. **Gonneke W.J.M. Stevens:** Writing – review & editing. **Angeline Chatelan:** Writing – review & editing. **Manon Rouche:** Writing – review & editing. **Els Clays:** Writing – review & editing. **Katrijn Delaruelle:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The present study used data from the HBSC study. Access to the raw data can be requested through the following link: https://www.uib.no/en/hbscdata/113290/open-access.

Acknowledgements

HBSC is an international study carried out in collaboration with WHO/EURO. The International Coordinator was Candace Currie (University of St Andrews) for 2001/02, 2005/06, 2009/10 and 2013/14 surveys. The Data Bank Manager was Professor Oddrun Samdal (University of Bergen). The 2001/02, 2005/06, 2009/10 and 2013/14 surveys included in this study were conducted by the following Principal Investigators in the 21 countries: Austria (Rosemarie Felder-Puig, Wolfgang Dür), Belgium [Flemish Belgium (Anne Hublet, Carine Vereecken, Lea Maes), French Belgium (Danielle Piette, Isabelle Godin)], Croatia (Ivana Pavic Simetin, Marina Kuzman), Denmark (Mette Rasmussen, Pernille Due), Estonia (Katrin Aasvee, Mai Maser), Finland (Jorma Tynjälä), France (Emmanuelle Godeau), Greece (Anna Kokkevi), Hungary (Àgnes Németh, Anna Aszmann), Ireland (Michal Molcho, Saoirse Nic Gabhainn), Italy (Franco Cavallo), Netherlands (Wilma Vollebergh, Tom ter Bogt), Norway (Oddrun Samdal), Poland (Joanna Mazur, Barbara Woynarowska), Portugal (Margarida Gaspar de Matos), Russia (Oleg Churganov, Alexander Komkov), Slovenia (Helena Jericek, Eva Stergar), Spain (Carmen Moreno Rodriguez), Sweden (Petra Lofstedt, Lilly Augustine, Ulla Marklund), Ukraine (Olga Balakireva), and United Kingdom [England (Fiona Brooks, Antony Morgan, Caroline Mulvihill), Scotland (Jo Inchley, Candace Currie) and Wales (Chris Roberts)]. Some of the data in this publication are based on the European Social Survey (ESS) Multilevel Data. The data are prepared and made available by NSD - Norwegian Centre for Research Data. NSD is not responsible for the analyses/interpretation of the data presented here. This work was supported by the government of Flanders. The Health Behaviour in School-aged Children survey is funded by public sources in each member country. The funding source had no role in the design or conduct of the study. Authors' contributions: M.D. designed the study based on an initial conceptualisation by B.D.C. and had primary responsibility for writing and editing of the article and performing the analysis and interpretation of the results. All co-authors assisted in interpreting the results and critically reviewed the manuscript. All authors listed gave final approval for the article to be published.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107339.

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