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Changes over time of fruit, vegetable and sweets consumption among European adolescents and associations with sociodemographic characteristics: an HBSC study

Judit Queral[1,2], Annemieke Wargers[3], Lucia Tarro[1,2], Elisabet Llauradó[1,2], Rosa Solà[1,2,4], Wilma Jansen[3,5]

[1]Institut d'Investigació Sanitària Pere Virgili (IISPV), Avda. Josep Laporte 2, 43204 Reus, Spain
[2]Functional Nutrition, Oxidation, and Cardiovascular Diseases Group (NFOC-Salut), Healthy Environment Chair, Facultat de Medicina i Ciències de la Salut, Universitat Rovira i Virgili, Sant Llorenç21, 43201 Reus, Spain
[3]Department of Public Health, Erasmus MC, University Medical Center Rotterdam, Dr. Molewaterplein 40,3015 GD, Rotterdam, The Netherlands
[4]Hospital Universitari Sant Joan de Reus, 43204 Reus, Spain
[5]Department of Social Development, City of Rotterdam, Coolsingel 40, 3011 AD Rotterdam, The Netherlands

Address correspondence to Wilma Jansen, E-mail: w.jansen.1@erasmusmc.nl.

ABSTRACT

Background European adolescents do not eat enough fruits and vegetables and have a high sweets consumption. This study aims to analyse the changes in time of dietary behaviours related to sociodemographic characteristics, among European adolescents.

Methods Health Behaviour in School Age Children data (2013/14 to 2017/18), of European adolescents, aged 11- to15-year-old, were used. Family Affluence Scale identified socioeconomic status (SES). Changes in time of dietary behaviours and associations with sociodemographic characteristics were estimated by binary and multilevel logistic regression.

Results 182 719 adolescents were included, and 10/36 European countries showed a significant increase in daily fruit and vegetable consumption and 12/36 countries a significant decrease in sweets consumption over 4 years. The multilevel analysis showed that 13- and 15-year-old adolescents consumed fewer daily fruits and vegetables ($P < 0.001$) and more daily sweets ($P < 0.001$) than 11-year-old adolescents. Also, 15-year-old adolescents' sweets consumption change over time was less favourable ($P = 0.006$). Girls consumed more daily fruits, vegetables and sweets than boys ($P < 0.001$). Low SES adolescents consumed fewer daily fruits and vegetables than medium/high SES adolescents. Additionally, the low SES adolescents' vegetable consumption change over time was less favourable ($P < 0.001$).

Conclusions Dietary behaviour policy recommendations should be adapted for the sex, age and SES of the population.

Keywords dietary behaviour, socioeconomics factors, young people

Background

In 2017/18, more than half of 11- to 15-year-old European adolescents did not eat fruits or vegetables daily (at least one time per day) and 25% consumed sweets daily (at least one time per day).[1] These unhealthy behaviours can result in the development of non-communicable diseases (NCDs).[2,3] Therefore, knowing insights into the establishment of healthy behaviours is essential to designing effective prevention policies.[4]

The key factors that influence children's dietary behaviours can be divided into intrinsic (gender, age, genetics) and environmental factors. The environmental factors include family, peers, community and social factors.[5] Social factors, including socioeconomic status (SES), ethnicity, demographic characteristics, sociocultural education and exposure to media, are important determinants of adolescents' eating behaviours.[5,6]

According to data from the Health Behaviour in School Age Children (HBSC) study in 2010, older adolescents have less healthy lifestyles.[7] Adolescents with lower SES generally

J. Queral, PhD
A. Wargers, MSc
L. Tarro, PhD
E. Llauradó, PhD
R. Solà, Professor
W. Jansen, PhD

have worse dietary behaviours than higher SES adolescents.[8] For example, regarding fruit and vegetable intake, previous studies with HBSC trend-time data (2001–10) highlighted that adolescents with a higher SES are more likely to consume daily vegetables and fruits than low SES adolescents.[9,10] In these studies, the SES was assessed by the Family Affluence Scale (FAS) based on the financial situation of the parents.[11] Also, in a Dutch cross-sectional study with 8- to 12-year-old children, children with a high education level of the mother consumed more daily fruits and vegetables than the children with mothers with a low education level.[12] That is, the authors of the present manuscript highlight that the economic difficulties of families and poor knowledge about the beneficial aspects of consuming fruits and vegetables are two of the major reasons for the low consumption of fruits and vegetables in low SES adolescents.

Evidence highlighted that despite the demographic characteristic and ethnic heritage, the European countries' dietary guidelines have key points in common: consume adequate amounts of grains, vegetables and fruits with moderate intake of fats, sugars, meats, caloric beverages and salt.[13] However, the report of HBSC of 2014 detected some variation between countries and regions in the prevalence of many indicators that reinforce the importance of country-level factors and cultural norms in young people's health and well-being.[14]

Getting a dynamic view of changes over time in fruit or vegetable consumption of adolescents is challenging, which can be solved by using time-trend studies. Time-trend studies are a type of time series design (observational design), specifically the simplest version where the purpose of the analysis is a descriptive account of a pattern over time in a specific population.[15] Moreover, this type of study as epidemiological approach has often been used successfully to inform public health policy and practice.[16]

Hence, the present study was designed to get insight into the change over time in dietary behaviours in adolescents and provide directions for adequate policy measures in the future, considering the differences among populations in 36 European countries. The literature showed dietary trends regarding sugary and soft drinks, breakfast, fruit and vegetable consumption, but these are from previous years[17,18] focused on specific European countries[19–21] or not considering SES characteristics.[22] The previous trend studies showed an improvement in dietary behaviours such as an increase in daily fruit and vegetable consumption and a decrease in the consumption of sugar-sweetened beverages.[18,19,22]

For this reason, our present study aimed to analyse the change over time in dietary behaviours, including fruit, vegetable and sweets consumption, and the associations with sociodemographic characteristics such as sex, age and SES, using HBSC data, from 2013/14 to 2017/18 in European adolescents.

The present study hypothesizes that dietary behaviours will improve over time, that is fruit and vegetable consumption increase and sweets consumption decrease. Also, older and low SES adolescents are expected to have worse dietary behaviours than younger and medium/high SES adolescents.

Methods

Study design, population and database

This study used data from the HBSC study (2013/14 and 2017/18). The HBSC study is a cross-national research study into the health and well-being of adolescents across Europe and North America conducted in collaboration with the World Health Organization (WHO). The present study followed 'The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: cross-sectional studies' (Additional file S1).

In 2013/14 and 2017/18, respectively, 42 and 48 countries in Europe and North America took part in the survey.[8,23] Each country uses cluster sampling to select a proportion of young people aged 11, 13 and 15 every 4 years.[23] Countries were provided with sampling guidance notes and were required to submit a standardized sampling report with information on the strategy employed. This report is part of the metadata attached to each country and international data file. It was then collated and made available to the HBSC network by the Data Management Centre (MC) at the University of Bergen, Norway.[8,23] Data are collected in all participating countries through school-based surveys.[23] The HBSC study protocol of 2013/14 and 2017/18 has been previously explained in depth.[8,23]

The present study included data from 2013/14 to 2017/18 about fruit, vegetable and sweets consumption, and related sociodemographic characteristics (age, sex, SES) in 36 European countries. Countries that are not in the Europe region or did not participate in both years' surveys were excluded. A total of 182719 and 185245 European adolescents were included in the analysis from 2013/14 and 2017/18, respectively.

The included participants have answered at least one of the principal outcomes (fruit, vegetable or sweets consumption) in both years' surveys.

Ethics

We used open data from the HBSC study, accordingly, all participating countries received ethical approval from their respective medical ethical committees.[8,23]

Study participants, their schools and parents/guardians were fully informed about the research and procedures regarding confidentiality and anonymity, access to data and data storage. Written and/or oral procedures for 'informed' consent were used.[8,23]

Particularly, the present study was approved by the ethical committee of Erasmus Medical Center, the *Medisch Ethische Toetsings Commissie (METC) (Ref: MEC-2022-0771).*

Outcomes and explanatory variables

The principal outcomes are daily fruit, vegetable and sweets (chocolate and candy) consumption by the sum of answer options 'once daily' and 'more than once daily' from the question of weekly consumption in the HBSC survey.[8,23]

The sociodemographic characteristics were used as explanatory variables.

SES scored by FAS III

The HBSC study developed FAS in 1998 and FAS III added more items in 2013/14.[24]

In the 2013/14 and 2017/18 survey cycles, FAS III was operationalized based on six items (car ownership, own (bed)room, times per year of holidays with family abroad, computer/tablet ownership, number of bathrooms, owning a dishwasher).[8]

In accordance with the total score, a relative measure was used to divide FAS into three categories indicating either low (lowest 20% of the sample, total score between 0 and 7), medium (middle 60% of the sample, total score between 8 and 11) and high (highest 20% of the sample, total score between 12 and 13) family affluence.[8,11] Due to the low number of participants classified in high FAS in the current study, two categories are used called low SES and medium/high SES here-after.

Age and sex

In both surveys, participants were asked about their age and sex. Related to age, the adolescents were classified into 3 categories: 11-year-old (from 11 to <13-year-old), 13-year-old (from 13 to <15-year-old) and 15-year-old (≥15-year-old).

Statistical analysis

Descriptive statistics of sex, age, FAS and dietary behaviours for each age category, sex and year of data collection were calculated as frequencies % (*n*).

The change over time of dietary behaviours was estimated by binary logistic regression. Separate models were used (i) for each country adjusted by sex, age and FAS; (ii) for each sex adjusted by country, age and FAS and (iii) for each age adjusted by country, sex and FAS.

To know how the FAS, age and sex differences in dietary behaviours have evolved (from 2013/14 to 2017/18), a multilevel binary logistic regression was used.

Firstly, an empty model was built to calculate the ICC (Interclass Correlation Coefficient) and assess the log odds between clusters. Then, intermediate models of each interaction term (age∗year and sex∗year and FAS∗year) adjusted by main effects (age, sex, FAS and time) were carried out to see if there were significant differences between age, sex and FAS categories in comparison with the reference level (11-year-old, boys and medium/high FAS) in each dietary behaviour and see the interaction effects over time. The results of the logistic regression analysis are presented as Odds Ratios (ORs) with 99% confidence intervals (CIs).

To ensure the validity of the results, sensitivity analyses were done for different cut-off points of the outcome (Additional file S2). Statistical significance was set at $P < 0.01$. Analyses were performed with SPSS (Version 28.0. Armonk, NY: IBM Corp).

Results

Sample characteristics

A total of 367964 participants were included in the analysis. The participants' characteristics and the descriptive results of dietary behaviours by survey year and overall are described in Table 1.

No significant differences were found in the distribution by sex between the two survey years ($P = 0.284$). On the contrary, more 11-year-olds and fewer 15-year-olds were observed in 2017/2018 compared with 2013/2014 ($P < 0.001$). Also, more adolescents from medium/high SES and fewer adolescents from low SES were involved in 2017/2018 compared with 2013/2014 ($P < 0.001$).

Prevalence of dietary behaviours

The prevalence of the daily consumption of fruit, vegetable and sweets by age category and year split by sexes was shown (Additional file S3).

In comparison with the 2013/14 survey, the prevalence of fruit and vegetable consumption was significantly higher in 2017/18 in all age and sex categories ($P < 0.001$), except for fruit consumption in 15-year-old girls that showed a non-significantly higher prevalence in 2017/18 ($P = 0.217$).

Regarding daily sweets consumption, the prevalence decreased significantly from 2013/14 to 2017/18 in boys

Table 1 Participants' characteristics separated by survey year and overall

	2013/14	*2017/18*		*Total*
Included participants (n)	*182719*	*185245*		*367964*
Sex	*% (n)*	*% (n)*	*P-value*[a]	
Girls	50.8 (92 874)	50.7 (93 831)	0.284	50.7 (186 705)
Boys	49.2 (89 845)	49.3 (91 414)		49.3 (181 259)
Age category				
11 years old	32.3 (58 458)	34.2 (62 898)	<**0.001**	33.2 (121 356)
13 years old	34.7 (62 904)	34.4 (63 331)	0.053	34.6 (126 235)
15 years old	33.0 (59 825)	31.4 (57 804)	<**0.001**	32.2 (117 629)
Family Affluence Scale				
Low	41.4 (69 418)	36.0 (63 944)	<**0.001**	38.6 (133 362)
Medium	50.8 (85 113)	54.1 (95 976)	<**0.001**	52.5 (181 089)
High	7.9 (13 179)	9.9 (17 568)	<**0.001**	8.9 (30 747)
Dietary behaviours				
Fruit consumption	% (*n*)	% (*n*)		% (*n*)
Never	2.9 (5262)	3.1 (5658)		3.0 (10 920)
Less than once a week	5.9 (10 694)	6.4 (11 777)		6.1 (22 471)
Once a week	9.8 (17 796)	9.6 (17 796)		9.7 (35 592)
2–4 days a week	28.7 (52 423)	25.9 (47 899)		27.3 (100 322)
5–6 days a week	15.2 (27 715)	15.8 (29 289)		15.5 (57 004)
Once daily	17.8 (32 560)	17.8 (32 865)		17.8 (65 425)
More than once daily	19.7 (35 979)	21.5 (39 754)		20.6 (75 733)
Vegetable consumption				
Never	4.5 (8148)	4.7 (8681)		4.6 (16 829)
Less than once a week	5.6 (10 225)	5.8 (10 747)		5.7 (20 972)
Once a week	9.8 (17 898)	9.3 (17 224)		9.6 (35 122)
2–4 days a week	25.6 (46 572)	23.1 (42 635)		24.3 (89 207)
5–6 days a week	19.2 (34 945)	19.2 (35 382)		19.2 (70 327)
Once daily	19.1 (34 659)	19.7 (36 365)		19.4 (71 024)
More than once daily	16.2 (29 490)	18.2 (33 511)		17.2 (63 001)
Sweets consumption				
Never	3.9 (7151)	4.0 (7315)		3.9 (14 466)
Less than once a week	11.8 (21 520)	12.2 (22 486)		12.0 (44 006)
Once a week	18.9 (34 306)	18.6 (34 393)		18.7 (68 699)
2–4 days a week	28.1 (51 217)	28.4 (52 381)		28.3 (103 598)
5–6 days a week	12.9 (23 551)	13.0 (24 048)		13.0 (47 599)
Once daily	12.6 (22 869)	12.8 (23 567)		12.7 (46 436)
More than once daily	11.7 (21 371)	11.0 (20 345)		11.4 (41 716)

[a] *P*-value obtained with Chi[2] analysis.

Bold values show significant *P*-value ($P < 0.01$).

of 13-year-old ($P = 0.006$). Girls and other age categories showed no significant difference.

Change over time of dietary behaviours by country

The change over time of each dietary behaviour from 2013/14 to 2017/18 adjusted by age, sex and FAS split by country are presented in Table 2.

From 2013/14 to 2017/18, 10 of 36 European countries had a significant increase in daily fruit consumption and 16 of 36 countries showed a significant increase in daily vegetable consumption. Additionally, 10 of 36 countries resulted in a significant increase in both outcomes, with an OR range from 1.109 to 1.859 in daily fruit consumption and an OR range from 1.124 to 1.588 in daily vegetable consumption. Albania had the highest increase in daily fruit consumption [OR (99%

Table 2 Change over time of daily dietary behaviours consumption adjusted by age, sex and FAS split by country from 2013/14 to 2017/18

Country	*Daily fruit consumption*[a,b] *OR (99% CI)*[c]	*Daily vegetable consumption*[a,b] *OR (99% CI)*[c]	*Daily sweets consumption*[a,b] *OR (99% CI)*[c]
Albania	1.859 (1.582, 2.185)**	1.430 (1.224, 1.670)**	1.157 (0.988, 1.355)
Austria	0.853 (0.750, 0.969)*	1.154 (1.007, 1.322)**	0.861 (0.749, 0.989)**
Belgium (Flemish)	1.505 (1.329, 1.704)**	1.311 (1.165, 1.474)**	1.024 (0.893, 1.176)
Belgium (French)	0.915 (0.827, 1.012)	1.048 (0.947, 1.160)	0.733 (0.661, 0.813)**
Bulgaria	1.008 (0.898, 1.132)	1.022 (0.912, 1.145)	0.750 (0.669, 0.841)**
Croatia	0.966 (0.864, 1.081)	0.973 (0.865, 1.096)	0.744 (0.661, 0.838)**
Czech Republic	1.470 (1.340, 1.612)**	1.588 (1.439, 1.753)**	0.984 (0.882, 1.097)
Denmark	0.759 (0.663, 0.869)*	1.071 (0.937, 1.224)	0.995 (0.758, 1.306)
Estonia	1.437 (1.276, 1.620)**	1.466 (1.291, 1.666)**	0.943 (0.826, 1.077)
England	1.109 (0.981, 1.254)	1.036 (0.917, 1.171)	0.827 (0.713, 0.959)**
France	0.935 (0.850, 1.029)	0.847 (0.771, 0.929)*	0.931 (0.835, 1.037)
Germany	1.001 (0.896, 1.118)	1.124 (0.995, 1.269)**	0.848 (0.750, 0.958)**
Greece	0.934 (0.823, 1.061)	0.969 (0.856, 1.098)	1.005 (0.854, 1.183)
Hungary	0.811 (0.712, 0.923)*	0.835 (0.730, 0.955)*	0.678 (0.592, 0.776)**
Iceland	1.042 (0.957, 1.135)	1.184 (1.083, 1.294)**	1.945 (1.530, 2.472)*
Ireland	1.077 (0.949, 1.221)	0.957 (0.845, 1.085)	0.704 (0.606, 0.819)**
Italy	0.914 (0.810, 1.032)	0.988 (0.865, 1.128)	0.890 (0.781, 1.015)
Latvia	0.979 (0.867, 1.105)	1.056 (0.936, 1.192)	0.770 (0.681, 0.871)**
Luxembourg	1.005 (0.880, 1.149)	1.166 (1.017, 1.336)**	1.068 (0.920, 1.240)
Malta	0.991 (0.843, 1.164)	0.815 (0.685, 0.971)*	2.109 (1.771, 2.512)*
Republic of Moldova	1.672 (1.495, 1.870)**	1.137 (1.017, 1.270)**	0.914 (0.811, 1.031)
Netherlands	0.950 (0.843, 1.071)	0.903 (0.806, 1.011)	0.866 (0.765, 0.980)**
Norway	0.807 (0.701, 0.929)*	1.048 (0.911, 1.207)	1.099 (0.805, 1.501)
Poland	1.151 (1.026, 1.290)**	1.198 (1.065, 1.347)**	0.907 (0.802, 1.025)
Portugal	1.255 (1.129, 1.395)**	1.322 (1.179, 1.482)**	1.025 (0.885, 1.187)
Romania	1.060 (0.938, 1.198)	0.858 (0.756, 0.974)*	0.938 (0.830, 1.059)
Russia	1.001 (0.888, 1.129)	0.935 (0.830, 1.055)	0.983 (0.870, 1.112)
Slovakia	1.259 (1.118, 1.418)**	1.496 (1.322, 1.694)**	0.985 (0.873, 1.110)
Slovenia	1.134 (1.020, 1.261)**	1.583 (1.415, 1.771)**	1.150 (1.001, 1.321)*
Spain	1.080 (0.972, 1.200)	1.387 (1.234, 1.559)**	1.106 (0.953, 1.282)
Sweden	0.993 (0.884, 1.116)	1.155(1.040, 1.282)**	1.604 (1.261, 2.040)*
Switzerland	0.941 (0.860, 1.030)	1.024 (0.936, 1.120)	1.027 (0.931, 1.132)
Ukraine	0.812 (0.731, 0.901)*	0.926 (0.835, 1.028)	0.859 (0.772, 0.956)**
Macedonia	1.182 (1.053, 1.327)**	1.194 (1.064, 1.340)**	0.966 (0.857, 1.090)
Scotland	0.862 (0.774, 0.960)*	0.885 (0.795, 0.985)*	0.729 (0.651, 0.815)**
Wales	1.069 (0.976, 1.171)	0.977 (0.893, 1.068)	0.945 (0.854, 1.045)

Abbreviations: OR, Odds Ratio; CI, Confidence Interval. [a]Positive change over time: an increase over time in daily fruit and vegetable consumption and a decrease in daily sweet consumption.

[b]Negative change over time: decrease over time in daily fruit and vegetable consumption and an increase in daily sweet consumption.

[c]Binary logistic regression of dietary outcomes adjusted by sex, gender, age and FAS split by country.

*Negative and significant change over time ($P < 0.01$).

**Positive and significant change over time ($P < 0.01$).

CI) = 1.859 (1.582, 2.185), $P < 0.001$], whereas the Czech Republic had the highest increase in daily vegetable consumption [OR (99% CI) = 1.588 (1.439, 1.753), $P < 0.001$].

Regarding the daily sweets' consumption, from 2013/14 to 2017/18, 12 of 36 European countries had a significant decrease with an OR range from 0.678 to 0.907. The Nether-

Table 3 Change over time in dietary behaviours daily consumption by age, sex and FAS from 2013/14 to 2017/18

	Daily fruit consumption OR (99% CI) change over time[a]	*Daily vegetable consumption OR (99% CI) change over time*[a]	*Daily sweets consumption OR (99% CI) change over time*[a]
Age			
11 years old	1.062 (1.028, 1.096)*	1.089 (1.054, 1.125)*	0.948 (0.912, 0.986)*
13 years old	1.061 (1.027, 1.096)*	1.115 (1.079, 1.152)*	0.908 (0.876, 0.942)*
15 years old	1.045 (1.010, 1.081)*	1.081 (1.045, 1.118)*	0.906 (0.873, 0.940)*
Sex			
Girls	1.044 (1.017, 1.071)*	1.095 (1.067, 1.124)*	0.927 (0.900, 0.955)*
Boys	1.066 (1.038, 1.096)*	1.093 (1.063, 1.124)*	0.911 (0.882, 0.940)*
FAS			
Low FAS	1.071 (1.038, 1.105)*	1.056 (1.024,1.090)*	0.917 (0.887, 0.948)*
Medium/High FAS	1.045 (1.020, 1.070)*	1.119 (1.092, 1.146)*	0.921 (0.895, 0.947)*

This table shows the change over time from 2013/14 to 2017/18 in each dietary behaviour adjusted by age and/or sex and/or FAS and country split by age categories, sex and FAS categories. Abbreviations: OR, Odds Ratio; CI, Confidence Interval

[a]Binary logistic regression of dietary outcomes adjusted by sex, age, FAS and country.

*P-value < 0.01.

lands showed the highest decrease [OR (99% CI) = 0.866 (0.765, 0.980), $P = 0.003$].

The change over time by country highlighted that daily fruit and/or vegetable consumption showed a positive and significant change in most Eastern Europe countries. On the contrary, daily sweets consumption was reduced in mostly Western European countries. However, in both Western and Eastern Europe, a negative and significant change of dietary behaviours (fruit, vegetable and sweets consumption) was observed (Table 2).

Change over time of dietary behaviours by age, sex and FAS categories

From 2013/14 to 2017/18, the change over time by age, sex and FAS showed a significant increase in daily fruit and vegetable consumption and a significant decrease in daily sweets consumption in all age, sex and FAS categories (Table 3).

Multilevel analysis: main effects and interaction effects over time between sociodemographic characteristics in dietary behaviours

The multilevel analysis showed main effect differences and interaction effects over time (from 2013/14 to 2017/18) in dietary behaviours between sociodemographic characteristics (Table 4). Focussing on age categories, 13- and 15-year-old adolescents consumed fewer daily fruits and vegetables than 11-year-old adolescents ($P < 0.001$). However, the interaction effects did not show significant change over time (from 2013/14 to 2017/18) differences ($P > 0.01$). Furthermore, 13- and 15-year-old consumed more daily sweets than 11-year-old adolescents ($P < 0.001$). In addition, the interaction effect showed that 15-year-old adolescents had a significantly less favourable change over time in sweets consumption than 11-year-old adolescents ($P = 0.006$).

Related to sex, girls consumed more daily fruits, vegetables and sweets than boys ($P < 0.001$). However, the interaction effect indicated a similar change over time between sex categories in fruits ($P = 0.077$); vegetables ($P = 0.888$) and sweets ($P = 0.967$) consumption.

Regarding FAS categories, low SES adolescents consumed fewer daily fruits and vegetables than adolescents with medium/high SES ($P < 0.001$). Additionally, the interaction effect showed a less favourable change over time in daily vegetable consumption in low SES adolescents than medium/high SES ($P < 0.001$), but a similar change over time between FAS categories in daily fruit consumption ($P = 0.195$). However, no significant differences were found for main effects and interaction effects over time in daily sweets consumption between FAS categories.

Sensitivity analysis

In the sensitivity analysis, the selected cut-off points were (i) more than once daily fruit and vegetable consumption and (ii) weekly sweets consumption (Additional file S2). Regarding change over time by country, five extra countries showed significantly positive results in fruit and sweets consumption, and six extra countries in vegetable consumption. However, five countries, showing positive and significant changes in time in the main analysis, do not show this in the sensitivity analysis.

Table 4 Multilevel analysis: main effects differences and Interaction effects in dietary behaviours between sociodemographic characteristics over time (from 2013/14 to 2017/18)

	Daily fruit consumption		*Daily vegetables consumption*		*Daily sweets consumption*	
	OR (99% CI) main effects[a]	*OR (99 CI) interaction*[b]	*OR (99% CI) main effects*[a]	*OR (99 CI) interaction*[b]	*OR (99% CI) main effects*[a]	*OR (99 CI) interaction*[b]
Age						
11 years old	Ref	Ref	Ref	Ref	Ref	Ref
13 years old	0.729 (0.706, 0.752)*	1.000 (0.956, 1.045)	0.847 (0.820, 0.875)*	1.024 (0.979, 1.072)	1.208 (1.163, 1.254)*	0.962 (0.913, 1.013)
15 years old	0.611 (0.592, 0.632)*	0.963 (0.920, 1.008)	0.809 (0.782, 0.836)*	0.976 (0.932, 1.022)	1.213 (1.168, 1.260)*	0.946 (0.897, 0.997)*
Sex						
Girls	1.375 (1.339, 1.412)*	0.975 (0.940, 1.012)	1.379 (1.342, 1.416)*	0.998 (0.961, 1.036)	1.201 (1.165, 1.238)*	0.999 (0.958, 1.043)
Boys	Ref	Ref	Ref	Ref	Ref	Ref
FAS						
Low FAS	0.712 (0.692, 0.733)*	1.020 (0.981, 1.059)	0.767 (0.745, 0.790)*	0.941 (0.905, 0.979)*	0.983 (0.952, 1.016)	0.998 (0.956, 1.042)
Medium/High FAS	Ref	Ref	Ref	Ref	Ref	Ref

This table shows the main effects difference between sociodemographic characteristics categories and interaction effects over time (2013/14 versus 2017/18) between sociodemographic categories in each dietary behaviour in comparison with the reference category (11-year-old and medium + high FAS participants). Abbreviation: Ref, Reference level category; OR, Odds Ratio; CI, Confidence Interval.

[a]Main effects differences between age, sex and FAS categories in dietary behaviours by the multilevel binary logistic regression with country as a level.

[b]Interaction effects of age, sex and FAS categories over time (from 2013/14 to 2017/18) by multilevel binary logistic regression with country as a level.

*P-value < 0.01.

Focussing on multilevel analysis, the main effects differences showed the same results as the original cut-off, except for low SES adolescents that had less sweets consumption (more than once daily) than medium/high SES.

Related to the interaction effect, the low SES adolescents showed a significantly more favourable change over time than medium/high SES adolescents in fruit consumption. Moreover, 13- to 15-year-old adolescent showed a less favourable change over time than 11-year-old adolescents in fruit and vegetable consumption.

Finally, in weekly sweets consumption, low SES adolescents showed a significantly less favourable change over time than medium/high SES adolescents.

Discussion

Main findings of this study and what is already known on this topic

In 2017/18, respectively, 39.3% and 37.3% of 11- to 15-year-old adolescents of 36 European countries consumed fruits and vegetables every day. This is an increase compared with the previous HBSC report from 2009/10, which showed a prevalence of 36.3% in daily fruit consumption and of 33.0% in vegetable consumption.[25] However, these improvements are not enough, as many adolescents still do not consume fruits and vegetables every day. Additionally, the prevalence of daily sweets consumption (chocolate and candy) was 23.8% in 2017/18. A HBSC trend study from 2002 to 2014 showed that in 2014 21% of adolescents from the Czech Republic consumed sweets daily, but in the present study, this percentage is higher because is considering all European adolescents.[26]

According to the recommendation of the European Society for Paediatric Gastroenterology, Hepatology and the Nutrition Committee on Nutrition, children and adolescents should reduce their sugar intake to <5% daily energy, meaning daily 27–32 g of added sugar for adolescents between 13 and 15 years old.[27] For example, 50 g of chocolate (two squares) contains 27 g of added sugar, making it easy to exceed the recommendation of daily added sugar, also in the 23.8% of adolescents in this study.

Focussing on country specific change over time of fruit and vegetable consumption, a significant increase in daily fruit consumption is shown in 10 of 36 European countries, as well as a significant increase in daily vegetable consumption in 16

of 36 European countries. A similar study of HBSC data from 2002 to 2010 resulted in a significant increase in daily fruit consumption in 22 of 33 European countries and in daily vegetable consumption in 18 of 33 countries.[18] These increases in fruit and vegetable consumption in more countries compared with the present study could be explained by the higher sample size and/or the more survey years analysed: 3 waves of the HBSC survey (2002/03, 2006/07 and 2010/11) instead of 2 waves (2013/14 and 2017/18).[18]

Most countries that increased daily fruit and vegetable consumption are from Eastern Europe. This observation is supported by a recent narrative review that highlighted the improvement of dietary patterns, including fruit and vegetable consumption, evident since 1990 in Western European countries, also being visible in Eastern European countries in the last two decades, since 2000.[28] A previous study on fruit and vegetable consumption showed that the majority of countries with higher prevalence in 2010 were from Western Europe, whereas the majority of Eastern countries showed a lower prevalence of fruit and vegetable consumption. Possibly in the present study, most Eastern countries had a significant positive catch-up as they set off with a lower prevalence.[18]

Currently, the WHO is implementing some policy recommendations to address fruit and vegetable consumption, e.g. EU school scheme: distribution of fruit, vegetables and milk from nursery to secondary school across the European Union.[29] Nevertheless, it is necessary to expand policy recommendations because the initiative of the school scheme did not involve all European countries (only 27 countries) and, in the present study, only 11 of these 27 countries showed a positive significant change over time in at least fruit and vegetable consumption. Moreover, reinforcing this policy is necessary in low SES high schools considering that adolescents of low SES consume fewer fruits and vegetables than their peers with higher SES.

The country-specific change over time in sweets consumption showed that the daily sweets consumption in adolescents decreased in 14 of 36 Europe countries. A previous study from Germany (1985–2016) also showed a decrease in the total sugar intake in children and adolescents since 2010.[30] The decrease in sugar consumption in the present study might be explained by 2015 recommended WHO guideline about the reduction of sugar intake to less than 10% of total energy.[31] Due to this recommendation, some policy recommendations were carried out in Europe to restrict or eliminate the choice of sugar-added food or beverages and introduce the recommendation of fiscal measures such as the taxation of sugar-sweetened beverages (SSB) and sugar-rich products.[32] Some European countries (Belgium, Finland, France, Hungary, Ireland, Norway, Portugal and United Kingdom) implemented taxes on SSB and/or sugar consumption between 2009 and 2018.[33] This can explain why most of these countries presented a positive and significant change over time in the present study. Nevertheless, this recommended sugar reduction is still important, as the present study showed that ≥20% of adolescents still consume sweets daily.

Recently, the European Programme of Work 2020–25 was agreed upon by all 53 Member States of the WHO European Region, aiming to promote healthy and sustainable diets, tackle the growing rates of obesity, and ensure good nutrition and food security through a range of activities. Among others, activities consist of (i) promoting school nutrition policies, (ii) restricting digital marketing of unhealthy foods and non-alcoholic beverages to children and adolescents, (iii) promoting policies to reduce salt, fats and sugars in diet, including food product reformulation and (iv) supporting fiscal policies including sugar-sweetened beverage tax and front-of-pack labelling.[34] These initiatives provide a good opportunity to improve the dietary behaviours of children and adolescents taking into account the relevant results of the present study.

The present study showed that older adolescents consumed fewer daily fruits and vegetables than younger adolescents. These results are in line with a European trend from 2002 to 2010.[35] Additionally, the present study demonstrated that older adolescents consumed more daily sweets with a less favourable change over time than younger adolescents. A study from Germany between 1985 and 2016 showed the opposite; older children consuming less sugar than younger children.[36] Justifying that the results differ among countries and the present study analyses the overall European level.

Focussing on SES inequality, low SES adolescents consumed fewer daily fruits and vegetables than medium/high SES adolescents. Also, the change over time in daily vegetable consumption was less favourable in low SES adolescents. These results are in line with a study among Nordic adolescents that showed that high SES students are more likely to report eating daily fruits and vegetables compared with low/medium SES adolescents. On the contrary, trends (from 2001/02 to 2009/10) in SES inequality in fruit and vegetable consumption did not differ across survey years.[9] The study did not show any significant associations between SES and sweets consumption.[9] Those less favourable changes over time for low SES groups means that inequities are increasing over time and probably reflect the devastating effects of the economic crisis on European society.[37] In future research, this potentially widening gap should be monitored and addressed.

Related to sex inequity, girls consumed more daily fruits, vegetables and sweets than boys, as was also found in a previous trend study on dietary behaviour among European adolescents.[35]

What this study adds

The present study provides new actual evidence about the change over time of dietary behaviours in European adolescents and the association with sociodemographic characteristics. These findings are very important to further underpin the development of public health policies to improve the diet of European adolescents.

Limitations of this study

As more recent data are not freely available yet, the data on the study are limited to the 2013/14 to 2017/18 period.

Related to future perspectives, studies with longer time-trend comparisons between European countries including more social factors (ethnicity, demographic characteristics, sociocultural education and exposure to media), and more details on consumed quantities might provide further evidence.

Furthermore, European policy recommendations aiming to prevent NCDs and improve dietary behaviour should reflect on the differences in age, sex and SES regarding daily fruit and vegetable consumption, which is a protective factor for NCDs. Key points to adapt policy recommendations should be, first, to offer fruits and vegetables in schools or high schools at the European level considering the SES of families. Secondly, educational strategies should be implemented to improve the knowledge about the importance of fruit and vegetable consumption: reaching low SES families to enable them to attain fruit and vegetable recommendations. Lastly, fruit and vegetable recommendations should be specified to sub-age categories such as younger adolescents (10–12 years old), middle adolescents (12–14 years old) and older adolescents (15–18 years old), not only divided by children or adolescents in general.

Conclusions

From 2013/14 to 2017/18, a significant and positive change over time, an increase was shown in the daily fruit and vegetable consumption and a decrease in sweets consumption of 11- to 15-year-old adolescents in 36 European countries. Especially in Eastern European countries, an increase in daily fruit and vegetables was perceived, whereas in Western European countries, a decrease in daily sweet consumption was observed.

Notably, older adolescents consumed fewer daily fruits and vegetables and more daily sweets than younger adolescents. In addition, girls consumed more daily fruits, vegetables and sweets than boys.

Related to SES inequality, low SES adolescents consumed fewer daily fruits and vegetables than adolescents with medium/high SES. In low SES adolescents, a less favourable change over time for vegetable consumption was shown.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

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Conflict of interest

The authors declare that they have no competing interests.

Authors' contributions

JQ, AW and WJ have made substantial contributions to the conception, design of the work; acquisition, analysis and interpretation of data and have drafted the work or substantively revised it. In addition, they have approved the submitted version and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

EL, LT and RS have made substantial contributions to the conception, design of the work; interpretation of data and have drafted the work or substantively revised it. In addition, they have approved the submitted version and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Data availability

The data underlying this article were provided by HBSC by permission. Data will be shared on request to the corresponding author with permission of HBSC.

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