



## Original Research

# Determinants of energy drink consumption in adolescents: identification of sex-specific patterns



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## ABSTRACT

**Objectives:** To investigate sex differences in sociodemographic and lifestyle correlates of frequent energy drink (ED) consumption in adolescents.

**Study design:** This study was based on data collected among French-speaking Belgian adolescents aged 11–20 years (n = 8137) within the 2018 Health Behaviour in School-aged Children study.

**Methods:** Multiple logistic analyses stratified by sex were performed to estimate the associations between consuming EDs more than once a week, and various sociodemographic and lifestyle characteristics.

**Results:** Overall, 14.0% of boys and 7.6% of girls consumed ED more than once a week. For both genders, the likelihood of consuming ED more than once a week was higher among adolescents consuming soft drinks daily (vs. < daily), alcohol weekly (vs. < weekly), spending at least 5 h/day in front of screens (vs. < 5 h/day), and going to bed later than 11:30 PM (vs. ≤ 10:00 PM). Among boys, adolescents reporting at least 1 h of moderate-to-vigorous physical activity (MVPA) daily (vs. < 1 h/day MVPA) were more likely to consume ED more than once a week (adjusted odd ratio (aOR) = 1.49 (95% confidence interval [CI] 1.11–2.01)). Among girls, adolescents from low affluence families (vs. high affluence) (aOR = 2.03 (95% CI 1.19–3.48)) and immigrants (vs. natives) (2nd generation: aOR = 1.75 (95% CI 1.31–2.32); 1st generation: aOR = 1.90 (95% CI 1.20–3.03)) were more likely to consume ED more than once a week.

**Conclusions:** We identified different patterns of ED consumption in boys and girls. These results suggest that sex-tailored interventions could be relevant to reduce ED consumption in adolescents.

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## Introduction

Energy drinks (EDs) are non-alcoholic beverages with high contents of caffeine, sugar and other ingredients having stimulating properties.<sup>1</sup> In the past decade, these drinks have become increasingly popular, particularly among adolescents and young adults.<sup>1,2</sup> ED are marketed as improving energy, concentration and physical capacity, and these marketing strategies are often targeted to adolescents and young adults.<sup>3</sup> However, consistent evidence has related frequent ED consumption with adverse health effects, including cardiovascular symptoms, respiratory disorders, sleep impairment, nervousness and gastrointestinal disturbances.<sup>2,4</sup> Children and adolescents may be more vulnerable to such effects because of their low body mass and increased sensitivity to

caffeine.<sup>5,6</sup> ED consumption in adolescents has also been associated with other risky behaviours (such as alcohol and substance use),<sup>5</sup> mental health problems,<sup>5,7</sup> and overweight and obesity.<sup>8</sup> In addition, mixing ED with alcohol has become a common practice among young people. This is problematic because it reduces the perception of alcohol intoxication which may lead to more rapid and excessive alcohol intake including binge drinking, and high-risk behaviours, such as driving while intoxicated and unprotected sex.<sup>9</sup>

Given the marketing strategies directed to youth, the popularity of ED and their negative health consequences, research is needed to identify sociodemographic and lifestyle factors associated with frequent use of ED, and thereby helping understand patterns of consumption. This is a crucial step to identify 'at-risk' adolescents and develop effective interventions and policy regulations.<sup>10</sup> Previous studies have consistently shown that male adolescents are more likely to consume ED, and in larger amounts, than females.<sup>1</sup> By contrast, positive associations, inverse associations and absence of association between ED consumption and age have been

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reported in the literature.<sup>1</sup> Similarly, both presence and absence of association between ED consumption, and socio-economic status,<sup>11–14</sup> family structure<sup>11,12,14</sup> or ethnicity<sup>1</sup> have been reported previously. Regarding lifestyle characteristics, higher ED consumption has been associated with higher screen time,<sup>13,15,16</sup> higher<sup>1</sup> or lower<sup>15</sup> physical activity, shorter sleep duration,<sup>17</sup> and higher alcohol and substance use.<sup>1</sup>

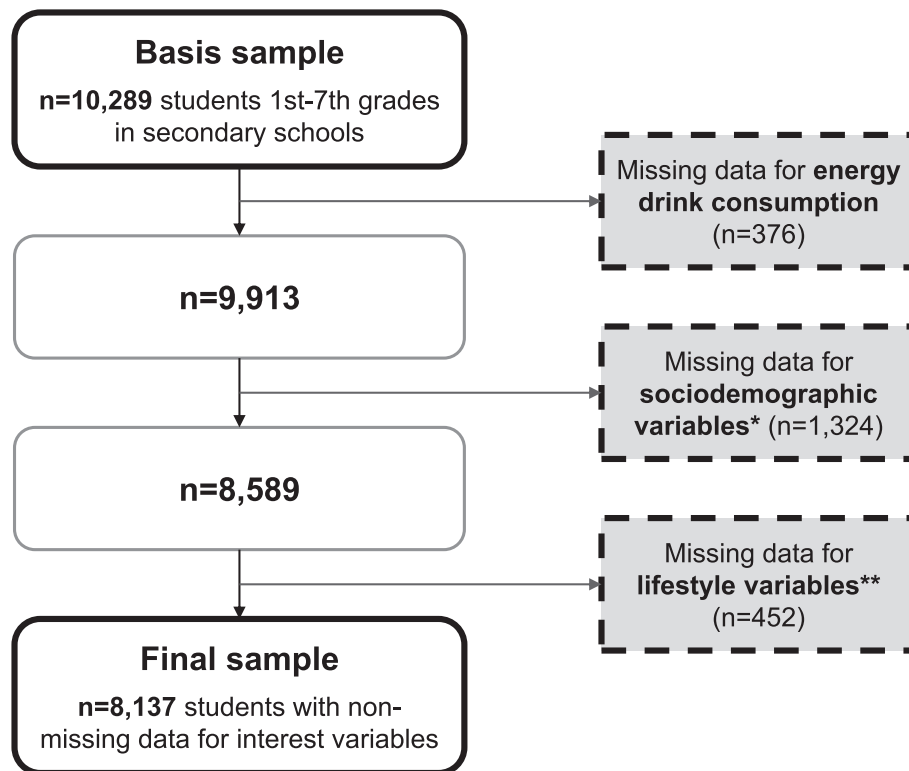
To our knowledge, no study has specifically investigated sex differences in the patterns of ED consumption among adolescents. However, the perception of risk and risk-taking behaviours are known to vary between sexes, with males being more impulsive and more likely to focus on the positive outcome of their behaviours, and females being more risk averse and more sensitive to possible subsequent punishments.<sup>18</sup> In addition, sex differences in subjective responses to caffeine have been documented in adolescents: boys are likely to be more sensitive to its reinforcing value and report more frequently consuming it to boost their feeling of energy and euphoria.<sup>19,20</sup> We therefore hypothesized that patterns of ED consumption could vary between sexes; such sex differences would be important to consider when developing prevention strategies, as different messages and approaches may be needed for boys and girls.<sup>21</sup> Based on this hypothesis, the aim of our study was to identify possible sex differences in sociodemographic and lifestyle correlates of frequent ED consumption in a large and representative sample of French-speaking Belgian adolescents.

## Methods

### Study design

This study is based on data collected within the cross-sectional ‘Health Behaviour in School-aged Children’ (HBSC) survey conducted in 2018 in French-speaking schools in Belgium. The HBSC study is an international school-based survey carried out every four years in around 50 countries.<sup>22</sup> Data about health status, health behaviours and well-being were collected through standardised questionnaires self-administrated in the classrooms and treated as confidential.

In French-speaking Belgium, the 2018 HBSC survey was approved by the Ethics Review Committee of the Faculty of Psychology (Université libre de Bruxelles, ULB) and the regional education boards of the school networks. Participants were selected using a two-stage cluster sampling method with schools as primary sample units and classes as secondary sample units. First, schools were randomly selected from an official school list stratified per province and school network, with an allocation proportional to the total school population size of each province and network (provided by census data), and using probability proportional to the school size (total number of pupils). Second, one class of each grade, from the fifth year of primary school to the last year of secondary school, was randomly selected in the participating schools. Students from selected classes and their parents were informed by



\* Family affluence scale, family structure, and migration status.

\*\* Soft drink consumption, alcohol consumption, moderate-to-vigorous physical activity, weekday screen time, and bedtime.

Fig. 1. Flow chart of inclusion in analyses.

letter distributed in the classroom several days before the questionnaire completion about the goal of the study, its anonymous and confidential nature, and their right to refuse to participate. A procedure of passive parental consent was followed, i.e. it was asked to the parents to fill in a form if they refused their child participation. In addition, students could refuse to participate in the survey on the day of questionnaire completion without any formal procedure.

For the present study, students in primary schools were excluded because of particular consumption profiles. Data from 10,289 adolescents in secondary schools were available for analysis (Fig. 1). Students with missing values for one or more study variables were excluded from the analyses. The final sample included 8137 adolescents (3897 boys and 4240 girls) aged 11–20-years-old (Fig. 1).

## Measures

### ED consumption

The frequency of ED consumption (mentioned as 'Energy drinks [Redbull®...']') was collected through a validated short Food Frequency Questionnaire (FFQ).<sup>23,24</sup> This FFQ included 20 food groups with seven answer categories: 'every day, more than once', 'once a day, every day', '5–6 days a week', '2–4 days a week', 'once a week', 'less than once a week', and 'never'. These categories were dichotomised to distinguish adolescents drinking ED more than once a week from those with a lower consumption frequency.

### Lifestyle variables

Daily soft drink consumption was assessed using the aforementioned short FFQ (mentioned as 'Coca® or other soft drinks that contain sugar [Fanta®, Caprisun®, Ice Tea®...]'). Weekly alcohol consumption was computed based on five items asking the consumption frequency of: 'beer', 'wine', 'spirits', 'alcopops (Bacardi Breezer®, Smirnoff Ice®...)', and 'any other drink that contains

alcohol', with five possible answer categories: 'every day', 'every week', 'every month', 'rarely', and 'never'.<sup>22</sup> Individuals with daily or weekly consumption for at least one of the five items were categorised as consuming alcohol once a week or more.

Moderate-to-vigorous physical activity (MVPA) was assessed using the question 'Over the past seven days, on how many days were you physically active for a total of at least 60 min per day?' originated from the 'Patient-centred Assessment and Counselling for Exercise Plus Nutrition' measure<sup>25</sup> and followed by eight answer options ranging from 'never' to 'seven days'. The variable was dichotomized to identify adolescents practicing at least 60 min of MVPA daily.<sup>26</sup>

Time spent in front of screens on weekdays was determined by asking how many hours a day (from Monday to Friday) the pupils usually spend: (1) watching TV, videos (including YouTube or similar services), or DVDs; (2) playing PC-games, TV-games (Playstation®, Xbox®, GameCube®...), or games on tablet, smartphone or any other devices; and (3) using a PC, tablet or smartphone for chatting online, surfing the internet, writing emails, homework..., in their free time.<sup>22</sup> All three questions had nine response options ranging from 'none at all' to 'about 7 or more hours a day'. Total screen time was computed as the sum of the three screen-based activity hours, and individuals were categorized, based on the frequency distribution, into: 'less than 5 h a day', 'between 5 and 8 h a day', and 'more than 8 h a day'.

Bedtime was investigated by asking the students when they usually went to bed if they had to go to school the next morning,<sup>22</sup> with 13 answer options ranging from 'before 8:30 PM' to '2:00 AM or later' with 30-min intervals. Based on the frequency distribution, the variable was recoded into three categories: '10:00 PM or before', '10:30–11:30 PM', 'midnight or later'.

### Sociodemographic variables

Students were invited to report sex, month and year of birth, and who they were living with in the house where they were living

**Table 1**  
Sociodemographic and lifestyle characteristics of French-speaking Belgian adolescents (weighted percentages or mean  $\pm$  SD) overall and in accordance with the frequency of energy drink (ED) consumption.

Characteristics	Total sample (n = 8137)	ED consumption		P-value*
		>once a week (n = 930)	≤once a week (n = 7207)	
<b>Age</b> in years (mean $\pm$ SD)	15.8 $\pm$ 2.1	16.3 $\pm$ 2.3	15.7 $\pm$ 2.1	<0.001
<b>Sex (%)</b>				<0.001
Male	49.0	63.9	47.2	
Female	51.0	36.1	52.8	
<b>Family affluence (%)</b>				<0.001
High	21.9	15.0	22.7	
Medium	59.4	60.0	59.3	
Low	18.7	25.0	18.0	
<b>Family structure (%)</b>				<0.001
Two-parent	61.0	52.8	62.0	
Blended	14.9	19.7	14.3	
Lone-parent	24.1	27.5	23.7	
<b>Migration status (%)</b>				<0.001
Natives	58.8	51.0	59.8	
2nd generation	29.4	33.6	28.8	
1st generation	11.8	15.4	11.4	
<b>Daily soft drink consumption (%)</b>	30.3	59.1	26.8	<0.001
<b>Weekly alcohol consumption (%)</b>	16.5	30.4	14.8	<0.001
<b>≥60 min MVPA daily (%)</b>	12.1	15.8	11.6	<0.001
<b>Weekday screen time (%)</b>				<0.001
<5 h a day	27.1	9.6	29.2	
5–8 h a day	29.7	21.6	30.7	
>8 h a day	43.2	68.7	40.1	
<b>Bedtime (%)</b>				<0.001
≤10:00 PM	41.6	26.0	43.5	
10:30–11:30 PM	42.9	42.5	43.0	
≥ midnight	15.5	31.5	13.5	

MVPA, moderate-to-vigorous physical activity.\* P-values of the design-adjusted Pearson's chi-squared tests. For age: P-value of the adjusted Wald test.

most of the time. This last information was used to classify adolescents into three types of family structure: ‘two-parent family’, ‘blended family’, and ‘lone-parent family’. Socio-economic status was assessed through the revised Family Affluence Scale (FAS), a six-item scale which has been previously validated.<sup>27</sup> Individual FAS scores ranging from 0 to 13 were subject to rdit transformation and classified into three groups, i.e. ‘low’, ‘medium’, and ‘high’, corresponding to the 20% of adolescents with the lowest FAS scores, 60% of adolescents with intermediate scores and 20% of adolescents with the highest FAS scores, respectively. The migration status was generated using the country of birth of the child and of his/her parents, and was defined as follows: the ‘natives’, i.e. the adolescents born in Belgium with both parents born in Belgium; the ‘second-generation immigrants’, i.e. those born in Belgium with at least one parent born abroad; and the ‘first-generation immigrants’, i.e. the adolescents born abroad with at least one parent born abroad.

*Statistical analyses*

All analyses considered the survey design (sample stratification and sampling units), were weighted, and stratified by sex. Descriptive analyses (frequencies or means and standard deviations) were conducted. Associations between ED consumption and sociodemographic and lifestyle characteristics were analysed using design-adjusted Pearson’s chi-squared tests (second-order Rao and Scott correction) for categorical variables and adjusted Wald tests for continuous variables. Multivariable logistic regression analyses were conducted to assess the associations between ED consumption and sociodemographic and lifestyle characteris-

tics. Statistical significance was set at  $P < 0.05$ . All analyses were conducted using the statistical software STATA® (version 14.2).

**Results**

In total, 10.7% of adolescents indicated that they consumed ED several times a week. The distribution for all sociodemographic and lifestyle characteristics differed in accordance with the level of ED consumption (Table 1).

Consuming ED more than once a week was more frequent among boys than girls (Table 2). In boys and girls, the percentage of adolescents consuming ED more than once a week was higher among adolescents with lower family affluence, those living in blended and lone-parent families, immigrants, those consuming soft drinks daily and alcohol weekly, and those having higher weekday screen time or later bedtime (Table 2). In boys only, consuming ED several times a week was more frequent among adolescents having at least 60 min MVPA daily than among those with lower levels of MVPA (Table 2).

In the multiple logistic models, the likelihood of consuming ED more than once a week was not associated with age, but was associated with daily soft drink consumption, weekly alcohol consumption, spending at least 5 h a day in front of screens, and bedtime later than 11.30 PM, in both sexes (Table 3). In boys, adolescents from blended families (vs. two-parent families) and reporting at least 1 h MVPA daily (vs. less than 1 h) were more likely to consume ED more than once a week, whereas consuming ED several times a week was not significantly associated with family affluence nor migration status. Second-generation immigrant boys were however more likely than natives to consume ED more than

**Table 2**

Weighted percentages of adolescents consuming energy drinks (EDs) more than once a week and once a week or less in accordance with sociodemographic and lifestyle characteristics, in boys and girls.

Characteristic	Boys (n = 3897)			Girls (n = 4240)		
	ED > once a week (%)	ED ≤ once a week (%)	P-value*	ED > once a week (%)	ED ≤ once a week (%)	P-value*
<b>Total (n)</b>	14.0 (591)	86.0 (3306)		7.6 (339)	92.4 (3901)	
<b>Family affluence</b>			0.04			<0.001**
High	11.1	88.9		3.6	96.4	
Medium	14.2	85.8		7.6	92.4	
Low	16.6	83.4		12.1	87.9	
<b>Family structure</b>			0.001			0.004
Two-parent	12.4	87.6		6.3	93.7	
Blended	18.6	81.4		10.1	89.9	
Lone-parent	15.2	84.8		9.3	90.7	
<b>Migration status</b>			0.04			<0.001
Natives	12.8	87.2		5.9	94.1	
2nd generation	17.9	82.1		10.5	89.5	
1st generation	15.0	85.0		9.7	90.3	
<b>Soft drink consumption</b>			<0.001			<0.001
<once a day	8.6	91.4		4.2	95.8	
≥once a day	25.1	74.9		16.2	83.8	
<b>Alcohol consumption</b>			<0.001			<0.001
<once a week	11.3	88.7		6.9	93.1	
≥once a week	23.6	76.4		12.8	87.2	
<b>MVPA</b>			0.006			0.46
<1 h daily	13.3	86.7		7.5	92.5	
≥1 h daily	18.0	82.0		8.6	91.4	
<b>Weekday screen time</b>			<0.001**			<0.001**
<5 h a day	5.4	94.6		2.5	97.5	
5–8 h a day	9.3	90.7		6.1	93.9	
>8 h a day	22.2	77.8		12.0	88.0	
<b>Bedtime</b>			<0.001**			<0.001**
≤10:00 PM	8.7	91.3		5.0	95.0	
10:30–11:30 PM	13.7	86.3		7.8	92.2	
≥midnight	24.8	75.2		16.9	83.1	

MVPA, moderate-to-vigorous physical activity.\* P-values of the design-adjusted Pearson’s chi-squared tests. \*\* P-value of the test for trend <0.001.

**Table 3**  
Adjusted odd ratios for the logistic models estimating the association between energy drink consumption more than once a week and sociodemographic and lifestyle characteristics, in boys and girls.

Characteristic	Boys		Girls	
	Adjusted OR (95% CI)*	P-value	Adjusted OR (95% CI)*	P-value
<b>Age (in years)</b>	0.99 (0.94–1.05)	0.74	0.98 (0.92–1.05)	0.57
<b>Family affluence</b>		0.57		0.04
High	Reference		Reference	
Medium	1.20 (0.86–1.68)		1.56 (0.98–2.48)	
Low	1.20 (0.79–1.81)		2.03 (1.19–3.48)	
<b>Family structure</b>		0.01		0.11
Two-parent	Reference		Reference	
Blended	1.40 (1.11–1.77)		1.49 (1.03–2.16)	
Lone-parent	1.00 (0.76–1.32)		1.10 (0.77–1.57)	
<b>Migration status</b>		0.06		<0.001
Natives	Reference		Reference	
2nd generation	1.30 (1.02–1.66)		1.75 (1.31–2.32)	
1st generation	1.46 (0.97–2.20)		1.90 (1.20–3.03)	
<b>Soft drink consumption</b>		<0.001		<0.001
<once a day	Reference		Reference	
≥once a day	2.71 (2.23–3.30)		3.18 (2.38–4.26)	
<b>Alcohol consumption</b>		<0.001		<0.001
<once a week	Reference		Reference	
≥once a week	2.36 (1.84–3.04)		2.39 (1.57–3.61)	
<b>MVPA</b>		0.008		0.58
<1 h daily	Reference		Reference	
≥1 h daily	1.49 (1.11–2.01)		1.12 (0.74–1.69)	
<b>Weekday screen time</b>		<0.001		<0.001
<5 h a day	Reference		Reference	
5–8 h a day	1.44 (1.01–2.04)		1.76 (1.01–3.09)	
>8 h a day	3.26 (2.27–4.68)		2.74 (1.52–4.93)	
<b>Bedtime</b>		<0.001		0.004
≤10:00 PM	Reference		Reference	
10:30–11:30 PM	1.14 (0.89–1.47)		1.21 (0.88–1.66)	
≥midnight	1.73 (1.29–2.31)		1.88 (1.30–2.74)	

OR, odd ratios; CI, confidence interval; MVPA, moderate-to-vigorous physical activity.\* Odd ratios adjusted for the other variables in the table.

once a week ( $P = 0.04$ ). In girls, adolescents from low affluence families (vs. high affluence) and immigrants (vs. natives) were at higher risk of consuming ED more than once a week, whereas consuming ED several times a week was not significantly associated with family structure nor MVPA. Girls from blended families were however more likely than those living with both parents to consume ED several times a week ( $P = 0.04$ ) (Table 3).

## Discussion

The aim of the present study was to investigate sex differences in sociodemographic and lifestyle correlates of frequent ED consumption in French-speaking Belgian adolescents. Our results indicated that for boys and girls, adolescents consuming soft drinks daily, alcohol weekly, with high screen time or with late bedtimes were more likely to consume ED more than once a week. These findings are consistent with previous cross-sectional studies conducted among adolescents which identified positive associations between ED consumption and consumption of other sugar-sweetened beverages,<sup>16</sup> alcohol consumption,<sup>5,11,14,28</sup> screen use,<sup>13,15,16</sup> and late bedtime<sup>17</sup> or short sleep duration.<sup>5,29,30</sup> Association between ED consumption and alcohol use may be partially due to the fact of adolescents mixing both substances. This growing behaviour is troubling considering it may decrease the perception of alcohol intoxication, and lead to higher alcohol intake, and engagement in various risky behaviours (e.g. binge drinking, unprotected sex or driving while intoxicated).<sup>4,9,31</sup> Furthermore, longitudinal studies have identified ED consumption as a predictor of using alcohol later in the adolescence.<sup>12,32</sup>

Regarding the association between ED consumption and screen time, previous studies have shown that screen use may negatively affect eating habits both quantitatively and qualitatively, due

notably to 'mindless eating', i.e. a lack of awareness of food consumption leading to overeating,<sup>33</sup> and exposure to food advertising that can influence the type and amount of food desired and consumed.<sup>34</sup> For ED specifically, branding and marketing have been identified as having a major influence on adolescent consumption, these drinks being advertised on the television and internet, via sport sponsorship and in shops.<sup>1</sup> In another point of view, Koivusilta et al.<sup>17</sup> have suggested that ED may be consumed by adolescents to stay awake late in the evening and therefore spend more time for screen-related activities, such as social media and video games. Furthermore, our results related to the association between ED consumption and bedtime may be explained by the negative impact of caffeine on children and adolescent sleep outcomes, both in terms of quantity and quality, owing to its stimulating properties.<sup>2</sup> A reverse association is also possible, with adolescents going to bed late drinking more ED to stay awake. Indeed, insufficient sleep and the desire to increase energy are the most common reasons for consuming ED.<sup>2</sup> Globally, the presence of these associations between ED consumption and other unhealthy behaviours is consistent with the Problem Behaviour Theory suggesting a clustering of unhealthy behaviours among some adolescents,<sup>10,35</sup> which should therefore be carefully monitored.

In both sexes, our results showed that regular ED consumption was not associated with age after adjustment for other socio-demographic and lifestyle variables. There is no consensus about this issue in the literature - some studies have found higher consumption frequency in older adolescents, others have highlighted the opposite<sup>1</sup> or have concluded to the absence of association.<sup>7,36</sup> In the present study, although the proportion of adolescents consuming ED more than once a week increased with age in unadjusted analyses (data not shown), this association was no longer significant in the multivariable logistic models. This change was



related to the introduction of bedtime, a variable closely associated with age in the models, which cancelled out the association with age in our final models.

Our study identified different patterns of ED consumption in boys and girls. First, among boys, the adolescents having at least 1 h of daily MVPA were more likely to consume ED more than once a week, compared with those having lower levels of MVPA. In contrast, a recent study conducted among Norwegian adolescents found that the odds ratio of being a high ED consumer increased when the frequency of physical activity decreased.<sup>15</sup> Other studies conducted in the U.S. and Saudi Arabia have found an absence of association between ED consumption and levels of physical activity,<sup>16,37,38</sup> or a positive association between both lifestyle factors.<sup>39</sup> Such discrepancies may come from methodological differences, including the assessment of physical activity and the absence of stratification by sex, or from various cultural and environmental backgrounds (e.g. in terms of branding, marketing and availability in schools). Our finding may be related to the marketing strategies for ED suggesting an improvement in physical capacity. The presence of this association in boys only may reflect the 'gendered' nature of marketing strategies used in Belgium, with, for instance, packaging designed to target boys specifically.

Second, consuming ED more than once a week was associated with family structure in boys but not in girls. However, the absence of association in girls was probably owing to a lack of statistical power. Even if the global association was not statistically significant for girls in the multiple logistic model, girls from blended families were still more likely than those living with two parents to consume ED several times a week. The finding that the likelihood of consuming ED more than once a week is higher among adolescents who are not living with both parents is in line with previous studies,<sup>11,14</sup> although family structure has mostly been considered as an adjustment rather than interest variable. In the literature, family factors, such as parental support, parental monitoring and permissiveness regarding deviant behaviour, or parental use, have been associated with substance use among adolescents and could explain the observed association.<sup>40</sup>

Third, in girls only, adolescents from low affluence families and immigrants were more likely to consume ED more than once a week, suggesting a higher sensitivity of girls to their living conditions in this field. In boys however, even if the overall association was not statistically significant, second-generation immigrants were still more likely than natives to consume ED several times a week. Regardless of sex, associations between ED consumption and socio-economic status<sup>7,14,15</sup> or ethnicity<sup>1,7,13</sup> have been identified in past studies. Absence of association with these sociodemographic characteristics has nevertheless also been reported.<sup>11,12,16,36</sup> Future qualitative studies should be conducted to further explore why these sociodemographic variables have a stronger influence among girls than in boys in the Belgian context.

Our results should be interpreted in the light of the study limitations. First, estimations may be subject to bias. On the one hand, they are based on self-reported measures and can therefore be influenced by recall or social desirability bias. On the other hand, 20.9% of the students were excluded from the analyses due to missing data for the interest variables (Fig. 1). Despite this reduction of the sample size, our study kept sufficient power and was able to detect small absolute differences in the proportions of boys and girls consuming ED several times a week (2.2 and 1.6 points of percentage for boys and girls, respectively, for a statistical power of 80%). Because excluded students had specific characteristics compared with included ones (e.g. higher percentages of boys, regular ED consumers, adolescents from low affluence families; data not shown), it may however have affected the strength of the associations estimated in this study. Second, because the short FFQ

used in this survey did not include sport drinks (i.e. drinks containing added sugars, minerals and electrolytes), there may have been some confusion for the adolescents between energy and sport drinks when they completed the questionnaire. Despite these limitations, the present study is based on a large and representative sample of adolescents, includes a wide range of sociodemographic and lifestyle variables, and provides new insights about sex-specific patterns of ED consumption among adolescents. It suggests the need for monitoring carefully adolescents with multiple unhealthy behaviours, and designing sex-tailored interventions to reduce ED consumption in adolescents.

## Author statements

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### Ethical approval

This survey was approved by the Ethics Review Committee of the Faculty of Psychology (ULB) and the regional education boards of the school networks. Students were clearly informed about the survey content and about their full right to not fill in the questionnaire or some questions within the questionnaire. A procedure of passive parental consent was followed: parents could refuse their child's participation by filling in a form previously provided together with information about the survey. All procedures implemented during the data collection enabled confidentiality and anonymity.

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### Competing interests

None declared.

### Authorship

The first author formulated the research question, analysed the data and drafted the manuscript. All authors participated in designing and carrying out the survey, revised the manuscript and approved the final version of the manuscript.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2020.05.040>.

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