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Children's and adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing

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Abbreviations

IFPS : International Food Policy Study

UK : United Kingdom

USA : United States of America

Word count : 5780

ABSTRACT

Objectives: The study objectives were to examine: 1) children's and adolescent's media viewing habits; 2) associations with media viewing and self-reported exposure to unhealthy food and beverage advertising; and 3) differences in trends among population subgroups (particularly between children and adolescents) in six high and upper-middle income countries.

Design: Repeat cross-sectional online survey.

Setting: Australia, Canada, Chile, Mexico, the United Kingdom (UK) and the United States (USA).

Participants: Respondents to the International Food Policy Study (IFPS) who provided information on all variables of interest in November-December 2019 aged 10 to 17 years (n=9171).

Outcome measures: Self-reported exposure to screen-based media (screen time by media channel), use of social media platforms, and location and frequency of exposure to unhealthy food and beverage advertising.

Results: The average amount of time spent in front of various screens ranged from 7.6 hours to 10.2 hours across countries per weekday. Overall, Instagram was the most popular social media platform (52-68% by country), followed by Facebook (42-79%) and Snapchat (28-52%). The percentage of respondents who reported having seen unhealthy food advertisements in the past 30 days was highest on television (43-69%), followed by digital media (27-60%) and gaming applications (10-17%). Self-reported exposure to advertising varied between countries for sugary drinks (10-43%) and fast food (19-44%), and was positively associated with screen time. Exposure to screen-based media and

social media platforms differed by socio-demographic characteristics, and was higher among adolescents than children.

Conclusions: The large percentages of children across all countries who report viewing screen-based media and high rates of advertising exposure, support the need for policies to restrict marketing of unhealthy food and beverages targeted at children and adolescents on screen-based media.

Keywords: Food marketing; food policy; marketing to children; broadcast media; digital media; children; adolescents; food environment

Article summary

Strenghts and limitations of this study

- The study has a large sample size, and employs the same measures across countries, allowing justifiable comparisons between countries.
- Assessed exposure to a wide range of social media platforms, and differentiated locations of exposure to screen-based marketing.
- Children and adolescents retrospectively self-reported the estimated screen time spent on each media channel rather than using a more objective approach.
- Self-reported exposure to marketing may result in an underestimation of exposure to marketing, and this study provides a conservative estimate.
- Time spent watching cable television vs. on streaming applications (Netflix, Crave, Amazon Prime Video, etc.) was not distinguished in this study.

1. Introduction

In recent decades, children and adolescents have become the targets of a variety of marketing techniques, many of which exploit their vulnerabilities. Children are most often not able to recognize the persuasive intent of marketing and may perceive it as entertainment, making them particularly susceptible to marketing content (1). Children and adolescents are a potentially important market segment, as effective marketing towards them can build early positive associations, create life-long consumers and brand relationships that extend into adulthood (2, 3). As such, the WHO and others have called for restrictions on marketing to children of specific products (such as tobacco or vaping products and unhealthy foods or beverages). Some jurisdictions, such as the province of Quebec (Canada), the UK, Chile and Mexico have implemented policies restricting unhealthy food marketing targeted at children typically 13 years and under (4), as it is well established that food marketing influences children's dietary preferences for products, consumption patterns, and shapes their purchasing behavior as well as their purchase requests to parents (5-8).

Effective food marketing depends on both exposure (defined as the number of people seeing the message and the frequency to which the person is exposed to the message) and power (defined as the "creative content, design and execution of the marketing message"), which both vary considerably between media channels or types (9, 10). Various marketing techniques are used across media channels to optimize the effectiveness of marketing, and may differ both in their impact on children as well as whether or not children can recognize them as advertising (7, 11-14). Screen-based media, which for the large part includes television, digital media (including social media)

and gaming sites, all have different implications with regard to the exposure and power of marketing messages that reach their audience.

Companies are increasingly using digital platforms as a complement to traditional advertising on television in a mixed-media approach to maximize the reach, efficiency and effectiveness of marketing (15, 16). Globally, time spent online on social media, gaming, streaming, and browsing the web is significant, and appears to be increasing in some countries (17-19), representing an important channel for advertising energy dense products (20-24). Given the shifting media consumption habits of children and adolescents, exploration of media consumption and associations with exposure to marketing of less healthy food products, and their patterning by demographic and socio-economic factors is warranted. Most studies to date that examine media consumption habits among children have been limited to a single media type, and do not examine exposure across multiple countries. This study aimed to explore children's and adolescent's media consumption habits (screen time and use of social media platforms) and associations with self-reported exposure to unhealthy food and beverage advertisements (location and frequency) across six high and upper-middle income countries (Australia, Canada, Chile, Mexico, UK and USA). As a secondary objective, the study aimed to examine differences in trends among population subgroups, and in particular differences in trends between children (10-13 years) and adolescents (14-17 years), the latter of which often fall outside the purview of policies restricting marketing of unhealthy food and beverages.

2. Subjects and methods

Data are from the 2019 International Food Policy Study (IFPS) Youth Survey, an annual repeat cross-sectional survey conducted in Australia, Canada, Chile, Mexico, the UK and the USA. Data were collected via self-completed, web-based surveys conducted in November-December 2019 with children and adolescents aged 10 to 17 years. Respondents were recruited through parents/guardians enrolled in the Nielsen Consumer Insights Global Panel and their partners' panels. Email invitations with unique survey links were sent to adult panelists within each country. Those who confirmed they had a child aged 10 to 17 living in their household were asked for permission for their child to complete the survey (only one child per household was invited). Children aged 10 to 17 years were eligible to participate, with quotas for age and sex groups in the UK and USA. After eligibility screening, all potential respondents were provided with information about the study and asked to provide assent. Surveys were conducted in English in Australia and the UK; Spanish in Chile and Mexico; English or French in Canada; and English or Spanish in the USA. Members of the research team who were native in each language reviewed the French and Spanish translations independently. The median survey time was 24 minutes.

The child's parent/guardian received remuneration in accordance with their panel's usual incentive structure (e.g., points-based or monetary rewards, chances to win prizes). A full description of the study methods can be found in the International Food Policy Study: Technical Report – 2019 Youth Survey at http://foodpolicystudy.com/methods/(25).

2.1 Total screen time and screen time by media channel and activity

Self-reported daily screen time was measured using the question: "*On a normal weekday, how much time do you spend…?*" Participants were asked to answer this question for five different media channels and/or activities: YouTube, social media (including messaging, posting, or liking posts); TV (shows, series, or movies); playing games (on smartphones, computers, or game consoles); and browsing (reading websites, Googling, etc.). Responses for amount of screen time for each media channel were captured using a scale (none; up to 15 minutes; up to 30 minutes; up to 1 hour; up to 2 hours; up to 3 hours; up to 4 hours; more than 4 hours; don't know; refuse to answer). The same question was presented afterwards for a "normal weekend day". Although the phrasing "up to" means that participants could have watched less than the stated value, the ceiling value was used to calculate an estimated amount of time in minutes spent on each media channel and all channels combined. For example, up to 15 minutes was recoded as 15 minutes, and up to 1 hour was recoded as 60 minutes. Those who responded "more than 4 hours" were recoded as 300 minutes (i.e., 5 hours). As children could have been viewing multiple media channels simultaneously, the sum of exposure (i.e., total minutes across all media types) was used as an overall indicator of total amount of exposure to screen-based media. Winsorization was used to limit the effect of extreme values on total screen time (26). The maximum amount of total screen time was set at the mean + 2 SD, in this case 1195 minutes for a weekday and 1268 minutes for a weekend day. Participants (n=572, weekday (6.2%) and n=432, weekend day (4.7%)) who exceeded this value had their total screen time decreased to the maximum. The winsorization technique yielded a slightly higher cutoff (+73 minutes) for weekends, as might be expected. The maximum amount obtained using this method was compared

with a hypothetical estimation based on an assumption that on a weekday, children and adolescents spend roughly 7 hours at school and 8 hours sleeping, which sums up to 15 hours. It is plausible that there may have been some screen time during school hours that would fall within the aforementioned categories (browsing or watching YouTube), and so it was assumed that this was approximately 1 hour. The total (14 hours) was subtracted from the length of a day (24 hours) to give a possible maximum of 10 hours of screen time, with a maximum of 20 hours if two screens were being used simultaneously. This estimation of 20 hours (1200 minutes) confirms the measure of total maximal screen time for weekdays (1195 minutes) and weekends (1268 minutes) has good face-validity.

2.2 Usage of social media platforms

Self-reported usage of various social media platforms was assessed using the measure: "*Do you use…? (select all that apply)*" (Response options: "Facebook", "Instagram", "TikTok", "Twitter", "Snapchat", "none of the above", "don't know" or "refuse to answer").

2.3 Location of exposure to unhealthy food and beverage advertisements

The location of exposure to advertisements was assessed using the question: "*Have you seen or heard advertisements for "unhealthy" foods or drinks in any of these places in the last 30 days?*" Participants were instructed "*Unhealthy food and drinks include processed foods high in sugar, salt, or saturated fat, such as soda/pop, fast food, chips, sugary cereals, cookies and chocolate bars.*" Participants could select all the responses that applied from a list of 13 potential media channels, and an 'other' option with an open-text box, or "I haven't seen any ads for unhealthy food in the last 30 days", "don't know" or "refuse to answer." In this study, three channels were analyzed that pertain to

screen-based media (television shows, series or movies; website or social media; and video or computer games). Open text data were reviewed, and responses were re-coded to be included as one of the categorical options as applicable. "YouTube" and "social media" were recoded to be included in the category "website or social media" and "TV" was re-coded in the category of television shows. When participants wrote "all" in the open text, these responses were coded in each category of marketing location.

2.4 Frequency of exposure to unhealthy food and beverage marketing

The frequency of exposure to unhealthy food and beverage marketing was assessed using the question: "*In the last 30 days, how often did you see or hear advertisements for these kinds of food or drinks*?" Participants responded for advertisements for six food categories, two of which were included in this analysis (sugary drinks; fast food from a restaurant). The frequency was assessed using a likert-type scale. (Response options: "never", "less than once a week", "once a week", "a few times a week", "everyday", "more than once a day", "don't know" and "refuse to answer"). Frequency of exposure was then recoded as a binary variable, where "everyday" and "more than once a day" were combined as "daily", and the other options combined as "less than once a day"; responses of "don't know" or "refused" were considered as missing.

2.5 Socio-demographic measures

Socio-demographic data included age, ethnicity, sex, country, school grades and perceived income adequacy. Age was included as a binary variable, (children aged 10 to 13 years, and adolescents aged 14 to 17 years). Ethnicity was assessed using unique measures from each country and re-coded to derive comparable measures across countries: *majority* or *minority* ethnicity. Participant's sex was self-reported by asking

"*Are you…"* with responses "male" or "female". School grades were measured using the question: "*What grades do you usually get in school?*" Response options varied across countries and were re-coded to derive comparable measures across countries and three groups were created: "low" (<grade of B in most countries), "mid" (grade of B in most countries) or "high" grades (grade of A in most countries). Perceived income adequacy was examined using the measure: "*Does your family have enough money to pay for things your family needs*?" (Response options: "not enough money", "barely enough money", "enough money", "more than enough money", "don't know" and "refuse to answer"). Perceived income adequacy was recoded as a binary variable, (not enough money/barely enough money were combined as "inadequate" and enough money/more than enough money were combined as "adequate"); responses of "don't know" or "refused" were considered as missing and excluded from analyses. Participant's body mass index (BMI) was calculated using self-reported height and weight. BMI was assessed using z-scores and classified according to the WHO recommendations (27). *Severe thinness, thinness* and *normal weight* were combined considering low levels of respondents for the *severe thinness and thinness* category (All countries = 2.9%, Australia = 3.3%, Canada = 4.2%, Chile = 0.9%, Mexico = 1.7%, UK = 2.8%, US = 3.0%). Extreme values were recoded as missing (z-score < -5 or > 5) according to the WHO growth reference guidelines (28). Extreme values as well as those participants whose height and/or weight were missing were coded as "not reported" and included in the analytic sample to reduce bias as potentially important differences between those who do not report their height and weight in population-level surveys have been identified

(29). A full list of measures in each country is available at http://foodpolicystudy.com/methods/ in the surveys section (30).

2.6 Data analysis

A total of 11,491 children and adolescents completed the survey. Respondents were excluded for the following reasons: region was missing, ineligible or had an inadequate sample size (i.e., Canadian territories); invalid response to a data quality question; and/or survey completion time under 10 minutes (n=383). The analytic sample included 11,108 respondents (Australia: n=1,435; Canada: n=3,682; Chile: n=1,252; Mexico: n=1,616; UK: n=1,520; USA: n=1,603). A sub-sample (N=9,171) was included in the current analysis after excluding respondents with missing data (including don't know and refuse to answer) for social media usage, screen time, location and frequency of exposure to unhealthy food and beverage marketing, ethnicity, school grades and perceived income adequacy (**Supplementary Figure S1)**. Data were weighted with post-stratification sample weights constructed using a raking algorithm with population estimates from the census in each country based on age group, sex, region, and ethnicity (except in Canada). Reported estimates are weighted.

Descriptive statistics were tabulated including the mean number of hours viewing screen-based media across all channels and by channel on a weekday and weekend day, the usage of each social media platform and mean number of social media platforms (maximum of 5 platforms), the frequency of the three advertisement locations and the percentage of respondents being exposed daily to advertisements for sugary drinks and fast food by country.

Regression models examined differences in the amount of exposure to screen-based media between countries and population subgroups. First, linear regressions were conducted with the amount of exposure to screen-based media (total screen time in minutes) as the dependent variable, including an indicator variable for country and variables for sex, age category (10-13 years, 14-17 years), ethnicity, perceived income adequacy, school grades, and BMI. Next, separate logistic regression models were conducted for each social media type (1=yes, 0=no), including an indicator variable for country and including the same list of correlates. Lastly, separate logistic regression analyses were used to examine associations between the exposure to screen-based media and daily frequency of self-reported exposure to advertisements for each of the food categories (sugary drinks; fast food from a restaurant), with daily exposure to sugary drink or fast food marketing as the dependent variable, including indicator variables for the amount of exposure on a weekday (continuous) and country, adjusting for the same demographic correlates. Separate models were tested for exposure to screen-based media on weekends. For all regressions, survey-aware procedures were used to account for finite sampling methods, and 99% confidence intervals are presented due to the use of multiple comparisons. Analyses were conducted using SAS v. 14.

2.7 Patient and public involvement

Patients and the public were not involved in the design, conduct, analysis or interpretation of the study. Study participants could have access to the study results upon request.

3. Results

Weighted sample characteristics are presented in **Table 1**. There were differences between countries in ethnicity group, school grades, perceived income adequacy and BMI. In general, a greater percentage of participants identified as a minority group in the USA, a smaller percentage had high school grades in Australia and the UK, and a greater percentage perceived their family income as adequate in Canada.

3.1 Exposure to screen-based media

Figure 1 shows the mean amount of total screen time for a weekday among participants across countries, which ranged from 7.6 hours (Canada and Australia) to 10.2 hours (Chile). Similar findings were observed across countries for a weekend day, but with higher total amounts (**Supplementary Figure S2**), which ranged from 8.9 hours (Canada) to 11.2 hours (Chile). Time spent on various media channels is shown in **Supplementary Figure S3**. Digital media, comprised of YouTube, social media and browsing, reading websites and Googling, was the largest contributor overall, and comprised 4.8 hours (weekday) and 5.4 hours (weekend day) on average. Browsing, reading websites and Googling accounted for the least amount of screen time on a weekday and weekend day in all countries. Across all countries, participants in Chile spent the highest amount of time on YouTube, social media, playing games and browsing, while participants in the USA spent the most time watching television on a weekday.

Estimates from a linear regression model examining the total amount of exposure to screen-based media on a weekday across countries is shown in **Table 2**. Total screen time differed by country, and across all demographic correlates. Participants in Canada and Australia reported less screen time than those in Chile, Mexico and USA; and Chilean

participants reported more screen time than those in all other countries except Mexico. Female participants self-reported less screen time than their male counterparts; adolescents spent more time on screens than children; participants from minority ethnicity groups and those who perceived their family income as inadequate had a greater self-reported exposure to screen-based media. Those who described themselves as having high grades in school (compared to low and moderate) spent less time on screens. Participants classified as having obesity had a greater total screen time than those of all other BMI categories and those who did not report their height and weight. Those who did not report their BMI (height and/or weight) had less screen time (compared to overweight) and those in the overweight category had greater screen time compared to participants in the severe thinness/thinness/normal weight category. The same pattern of results was observed for a weekend day, except for the findings on BMI, for which there were only associations between those with obesity vs. all other categories (**Supplementary Table 1**).

3.2 Social media exposure

The percentage of participants using different social media platforms across countries is shown in **Figure 2**. Overall, 77% to 87% of children were using at least one of the social media platforms, which varied by country. On average, the most commonly used platform was Instagram (range: from 52% in Australia and the USA to 68% in Chile), followed by Facebook (range: from 42% in Canada to 79% in Mexico), and Snapchat (range: from 28% in Chile to 52% in the UK). TikTok usage ranged from 20% (Mexico) to 32% (Canada) and Twitter usage ranged from 16% (Australia) to 34% (Mexico). Participants who reported no social media application use ranged from 13% (Mexico) to

23% (Australia). The mean number of social media platforms used per respondent across countries is shown in **Supplementary Figure S4**, and ranged from 1.9 platforms (Australia and Chile) to 2.2 platforms (Mexico).

Estimates from separate logistic regression models examining exposure to social media platforms across countries are shown in **Table 3**. Exposure to social media platforms differed by country and age group for all platforms, and significant differences by sex, perceived income adequacy, school grades and BMI for some platforms. Specifically, participants in Canada were less likely to use Facebook than those in all other countries, whereas participants in Mexico were more likely to use Facebook than those in all other countries. Those in Chile were more likely to use Instagram than those in all other countries. Participants from Canada were more likely to use TikTok than participants in Australia, Chile, Mexico, the UK. Participants in Mexico were more likely to use Twitter than participants in all other countries, and those in the UK were more likely to use Snapchat than those in all other countries except the USA. Participants in Australia were more likely to not use a social media platform compared to all other countries except the USA. Female participants were more likely to use Instagram, TikTok and Snapchat; adolescents (ages 14-17) were more likely to use all social media platforms except TikTok (compared to children ages 10-13); and ethnicity groups were not associated with exposure to social media platforms. Participants who perceived their family income as adequate were more likely to use Twitter; and participants who reported having high grades in school (compared to low and moderate) were less likely to use Facebook and TikTok. Those who were classified as having obesity were more likely to

use all social media platforms except Twitter compared to those whose BMI was is the category "not reported".

3.3 Location of screen-based exposure to advertisements for unhealthy foods or drinks

The percentage of children and adolescents who reported that they were exposed to advertisements for unhealthy foods or drinks in three locations in the previous 30 days is shown in **Figure 3**. Overall, TV shows, series or movies accounted for the largest number of participants self-reporting exposure to advertisements (range: from 43% in the UK to 69% in Mexico and Chile), followed by websites or social media (range: from 27% in the UK to 60% in Chile), and video or computer games (range: from 10% in Australia and the UK to 17% in Chile).

3.4 Daily exposure to sugary beverage and fast food advertisements

The percentage of respondents who reported that they were exposed daily to advertisements for both food categories in the last 30 days is shown in **Figure 4**. Self-reported daily exposure to sugary drinks advertisements ranged from 10% (UK) to 43% (Mexico). Self-reported daily exposure to fast food advertisements was relatively more consistent across countries, with the exception of the UK (range: from 19% in the UK to 44% in the USA).

Estimates from separate logistic regression models examining daily exposure to sugary beverage and fast food advertisements across countries are shown in **Table 4**. Participants who self-reported more time spent on screen-based media were more likely to report daily exposure to advertisements for both food categories. Daily exposure to advertisements for sugary drinks and fast food differed by country, BMI and amount of

exposure to screen-based media (total screen time in minutes), and patterns were mostly similar across both food categories; there was no significant difference in exposure by age group. Overall, participants in Mexico and Chile were much more likely to report daily exposure to sugary beverage advertisements than participants in all other countries, with fewer differences for fast food advertisements. Participants in the UK were less likely to report daily exposure to advertisements of sugary drinks and fast food compared to all other countries and those in the USA were more likely to report daily exposure to fast food advertisements than those in all other countries. Participants who did not report their height or weight were less likely to report daily exposure to advertisements for both types of food categories compared to participants living with obesity, overweight or in the severe thinness/thinness/normal weight category. There were no other significant differences by socio-demographic characteristics. The same pattern of results was observed for exposure to screen based media on a weekend day (**Supplementary Table S2**).

4. Discussion

Summary of main findings

This study found that children and adolescents across Australia, Canada, Chile, Mexico, UK and USA are spending considerable amounts of time viewing screen-based media. On average, children and youth reported between 7.5 hours and 10.2 hours of screen time, which varied by country. Digital media accounted for the most time on screens and social media use varied by platforms. Across all countries, self-reported exposure to advertisements in the past 30 days was reported most frequently on television, followed by digital media and gaming platforms. Between-country differences

were identified: participants in the UK reported less daily exposure to fast food and sugary drinks advertisements, whereas participants in the USA reported greater daily exposure to fast food advertisements. Most importantly, our results show that in all countries, self-reported exposure to advertisements increased with greater screen time. Analyses suggested important differences in exposure to screen-based media and social media platforms between age groups, with adolescents reporting an overall greater exposure to food advertisements.

Relationships with existing knowledge

The estimates from this study are similar to other international estimates of self-reported screen time. In the US, screen time among children 8-12 years in 2019 was estimated to be 4 hours 45 mins, and 7 hours and 22 minutes among 13-18 year olds,(31) compared to just over 9 hours in the current study among the older age group. A large national Canadian study from 2013-2014 suggest that youth ages 12 to 17 spent on average between 7.5 and 8 hours in front of screens daily,(32) very similar to the current findings of approximately 7.75 hours. In the current study, most children and adolescents are exceeding screen time guidelines across countries, which recommend entertainment screen time be limited to less than 2 hours daily for school-aged children and adolescents (33-35). Screen time has previously been associated with youth obesity (36, 37), poorer diet quality (38), and consumption of less healthy foods and beverages (39, 40). The general level of exposure reported among the sample, while an approximation, is cause for concern.

The large proportion of children and adolescents using social media platforms has important implications for food and beverage marketing. Companies are increasingly

developing strategies to engage with their audience through these media platforms, which have a high likelihood of reaching children and adolescents even when they are not the primary target audience. Research from Canada has estimated that children were exposed to food and beverage marketing (of which the great majority is "less healthy") on social media apps 30 times per week while adolescents were exposed on average 189 times per week (22). In our study, children and adolescents generally reported using two social media platforms on average, therefore exposing them to various types and amounts of marketing strategies across platforms. For instance, Instagram—the most commonly reported social media platform among participants—is known to promote poor nutritional quality foods and beverages are commonly promoted through popular brand accounts using a range of marketing strategies that appeal to children and adolescents, such as competitions and the use of characters that appeal to children (41). Unhealthy food brands on Facebook are known to use techniques such as competitions based on user-generated content, interactive games, and apps.(42) These results suggest a high level of exposure via social media.

In this study, a greater proportion of children and adolescents reported exposure to advertisements for unhealthy foods or drinks on television compared to websites, social media applications or gaming sites. Greater reporting may be in part due to the different types of advertising between these channels. In order for children to be aware of advertisements, they need to be able to identify the difference between an advertisement and other content, but also understand the persuasive intent behind the message (43). Self-reported exposure to advertisements on television may have been higher as it is more easily identifiable compared to digital marketing which often uses subtle marketing

techniques (e.g. such as celebrity endorsements by influencers and native advertising designed to imitate editorial content) and is frequently disguised as entertainment (43, 44). On digital media, children and adolescents may simply be less able to discriminate advertisements from other content, making marketing on these channels particularly alarming. Digital marketing via advertisements is typically targeted, using cookies and other means which record personal preferences, online activity, and location and these data are then used to personalize and target the content of marketing to individual users, therefore increasing the persuasive power of marketing (9, 11). The subtle advertising techniques used on digital media, such as influencer endorsements or advergames may be more likely to bypass children's cognitive awareness. However, our data align with marketing expenditure data, an objective indicator of marketing efforts by companies: fast-food advertisement expenditures are the highest for television, although digital marketing expenditures increased by 74% between 2012 and 2019 (45).

Self-reported daily exposure to advertisements was high for both fast food and sugary drinks, with 34% and 25% of the sample reporting daily exposure, respectively, in all countries. Perhaps unsurprisingly, those reporting more screen time were more likely to be exposed daily to sugary drink and fast food advertisements. Differences across countries may in part relate to differences in restrictions on marketing directed at children. In the UK, where participants were less likely to be exposed daily to advertisements for fast food and sugary drinks than those in all other countries, a total ban of advertisements for unhealthy foods and beverages has been in place since 2007 during and adjacent to television programs appealing to children and adolescents under the age of 16 (46). While evidence on the impact of the UK policy is mixed, findings

suggests that despite some changes in children's exposure, advertisements typically shifted to other media channels, implying important loopholes in regulations (47, 48). In the USA, where participants were more likely to report daily exposure to fast food advertisements than those in all other countries, voluntary self-regulatory approaches to restrict marketing by the industry are the only form of marketing restrictions, which target children under 12 years of age on media where the audience is mostly children (49), and have largely proven ineffective at decreasing children's exposure to marketing for unhealthy products (45, 50, 51). It is important to note that the present study cannot capture the effectiveness of restrictive marketing policies by its cross-sectional design, but studying trends in both screen-time and social media use and self-reported exposure annually over time using the IFPS should help evaluate the impact of impending policies, such as the recently announced policy in the UK which will ban online advertising by the end of 2022 and ban advertising of foods high in fat, sugar and salt between 5:30 am and 9 pm (52-54).

Age group was an important predictor for screen-based media and social media exposure, with adolescents spending more time on screens and using social media platforms more than children. Adolescents may be an age group of particular interest to marketers because of their greater spending power compared to children, which also increases with age, therefore having the potential to create life-long brand relationships and product consumers (55, 56). Marketers target adolescents through digital media by using "ubiquitous connectivity, personalization, peer-to-peer networking, engagement, immersion and content creation", which are features especially appealing to this age group (56). In our study, there were no differences in daily self-reported exposure to

sugary drink and fast food advertisements between children and adolescents. Despite adolescents having an improved ability to recognize advertisement content and the persuasive intent of marketing compared to their younger counterparts, adolescents may be even more vulnerable to digital food marketing, because of their increased use of these platforms as well as desire to conform with social norms in their peer group (57, 58). Greater exposure to digital and social media platforms may also increase the number of subtle marketing strategies, for example viral marketing (peer-to-peer), contests, quizzes and marketing by influencers, which may not be captured in self-report measures if the participant is unable to identify these as marketing strategies.

4.1 Strengths and limitations

This study has a large sample size, and the same measures were used across countries, allowing justifiable comparisons between countries. Many studies use expenditures or gross ratings points, which provide objective data, but do not indicate who is exposed at the individual level, including individual-level correlates. Furthermore, these traditional approaches are less effective for digital media. More intensive approaches—such as devices that directly monitor websites or device usage—provide precise measures of exposure but are typically less feasible at a population level. One of the major strengths of this study is the wide range of social media platforms, and the differentiated locations of exposure to screen-based marketing assessed. Self-reported exposure to food marketing is a method used by researchers in large population samples (57, 59, 60) as a subjective indicator of actual exposure, the latter likely to be higher because of the frequent and implicit nature of marketing, resulting in a probable underestimation of exposure to marketing. Our measures may further underestimate exposure as such a

measure may be less reliable in a sample of children and adolescents due to poor recall, and inability to recognize all forms of marketing (particularly in digital media) (61).

This study is subject to limitations common to survey research. Respondents were recruited using non-probability based sampling; therefore, although the data were weighted by age group, sex, region, and ethnicity (except in Canada), the findings do not provide nationally representative estimates. In addition, there were notably higher levels of missing data for BMI in the UK. The measures used also have some limitations. For example, time spent watching cable television vs. on streaming applications (Netflix, Crave, Amazon Prime Video, etc.) was not distinguished in this study. The amount of marketing exposure on cable television compared to streaming platforms is likely very different, and this may play an important role in understanding the amount of exposure. Additionally, children and adolescents retrospectively self-reported the estimated screen time spent on each media channel rather than using a more objective approach, and this may have been influenced by whether or not a parent was present when completing the survey. This approach has not yet been validated in the literature, but nevertheless seems comparable to self-report estimates from other surveys. Responses may not be precisely accurate, and likely overestimate the absolute amount of screen time reported by youth as the measure does not take into account simultaneous use of multiple screens. Nevertheless, this tool allows for comparisons of the relative amount of exposure across countries, as it is likely that the challenge of estimations, and associated error, would be similar across countries. Lastly, the measures did not distinguish between recreational screen time and screen time that was spent for school purposes (e.g., on websites).

4.2 Policy implications

These results reinforce the need to implement restrictive policies on marketing of unhealthy food and beverages targeting children and adolescents, not only on television but also on digital media considering the widespread usage of social media platforms among children and adolescents across countries and the persuasiveness of marketing that is often targeted. Future research examining the exposure to digital marketing to children, as well as research modelling of the impact of potential policy measures, are likely to be important in making the case for restricting less healthy food and beverage content via these channels (62). This study also demonstrated the variety of media channels that are being used by children and adolescents, even though their content may not be 'child-targeted'(63) (i.e., social media, websites, etc.) but are indeed 'child appealing'(62, 64). Almost all social media platforms (such as Instagram, Facebook and Snapchat) have a minimum age of 13 to register (65-67), but nearly a quarter of children aged 8 to 11 years have an account (68), demonstrating that self-imposed age-restrictions are not effective. The association between use and self-reported exposure further demonstrates the need for restrictions to limit exposure to this vulnerable age group.

The results of our study will be useful for future research as a baseline for comparison with exposure to unhealthy food marketing after the implementation of marketing policies, but also in comparing children's and adolescent's exposure to screen-based media and marketing after important worldwide events leading to possible changes in media consumption habits, such as the COVID-19 pandemic.

Ethics statement

The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 41477) and Laval University Ethics Committee (#2021-318). All participants provided informed consent to take part.

Contributorship statement

LV, CMW and DH designed research; CMW conducted research; EDP analyzed data and wrote the paper; LV had primary responsibility for final content; MW, MPK, DH, CN, CMW, XZ and LV reviewed and edited the manuscript. All authors read and approved the final manuscript.

Competing interests

None declared.

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Data availability statement

Data are available upon reasonable request. Data are available directly from the International Food Policy Study team on reasonable request (see www.foodpolicystudy.com).

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TABLES

Table 1. Sample characteristics of children and adolescents in six countries (weighted) N = 9171.

Characteristic	All countries (N=9171)	Australia (n=1127)	Canada (n=2869)	Chile (n=1124)	Mexico (n=1507)	UK (n=1140)	USA (n=1406)
				% (n)			
Age (years)							
10-13	50 (4551)	51 (574)	50 (1438)	47 (534)	50 (7[illegible])	49 (562)	49 (693)
14-17	50 (4620)	49 (553)	50 (1431)	53 (590)	50 (7[illegible])	51 (578)	51 (713)
Sex							
Male	51 (4664)	52 (582)	50 (1446)	51 (572)	51 (7[illegible])	51 (581)	51 (722)
Female	49 (4507)	48 (545)	50 (1423)	49 (552)	49 (7[illegible])	49 (559)	49 (684)
Ethnicity							
Majority group	76 (6976)	75 (850)	73 (2098)	85 (958)	78 (1170)	83 (941)	68 (959)
Minority group	24 (2195)	25 (277)	27 (771)	15 (166)	22 (335)	17 (199)	32 (447)
School grades							
Low	16 (1461)	32 (365)	13 (373)	6 (65)	7 (101)	29 (334)	16 (223)
Mid	38 (3508)	38 (430)	34 (974)	49 (555)	36 (549)	38 (430)	41 (570)
High	46 (4202)	29 (332)	53 (1522)	45 (505)	57 (855)	33 (375)	44 (613)
Perceived Income Adequacy							
Inadequate	24 (2222)	25 (283)	17 (488)	31 (345)	28 (418)	26 (291)	28 (397)
Adequate	76 (6949)	75 (844)	83 (2381)	69 (779)	72 (1089)	74 (849)	72 (1009)
BMI							
Severe thinness/thinness/normal weight	49 (4480)	45 (509)	57 (1630)	43 (478)	48 (717)	41 (462)	49 (683)
Overweight	18 (1665)	16 (176)	16 (473)	21 (231)	22 (334)	13 (147)	22 (304)
Obesity	10 (927)	10 (113)	9 (255)	9 (97)	10 (148)	8 (92)	16 (222)
Not reported	23 (2100)	29 (328)	18 (511)	28 (319)	20 (306)	39 (439)	14 (197)

Table 2. Estimates from a linear regression model examining the amount of self-reported exposure to screen-based media (in minutes) on a weekday among children and adolescents in six countries (N=9171).

Parameter	Weekday screen time	
	Wald χ^2	B (CI)
Country	64.2	
AUS vs. CAN		-18.1 (-47.2,11.0)
AUS vs. CHILE		-170.2 (-205.8,-134.5)
AUS vs. MEX		-144.3 (-179.3,-109.3)
AUS vs. UK		-26.8 (-60.7,7.2)
AUS vs. USA		-107.8 (-142.6,-72.9)
CAN vs. CHILE		-152.1 (-181.9,-122.3)
CAN vs. MEX		-126.2 (-154.9,-97.5)
CAN vs. UK		-8.7 (-37.7,20.3)
CAN vs. USA		-89.7 (-118.2,-61.1)
CHILE vs. MEX		25.8 (-9.1,60.8)
CHILE vs. UK		143.4 (107.9,178.9)
CHILE vs. USA		62.4 (26.7,98.0)
MEX vs. UK		117.6 (82.7,152.4)
MEX vs. USA		36.5 (1.9,71.2)
UK vs. USA		-81.0 (-116.1,-45.9)
Sex	25.3	
Female vs. male		-34.7 (-52.4,-16.9)
Age	209.4	
10-13 years vs. 14-17 years		-99.7 (-117.4,-81.9)
Ethnicity	18.5	
Majority vs. minority		-38.9 (-62.2,-15.6)
Perceived income adequacy	16.0	
Adequate vs. inadequate		-33.0 (-54.3,-11.8)
School grades	19.9	
High vs. low		-64.0 (-90.7,-37.2)
High vs. mid		-26.6 (-46.2,-7.0)
Low vs. mid		37.4 (10.6,64.1)
BMI	16.9	
Not reported vs. Obesity		-67.5 (-102.2,-32.8)
Not reported vs. Overweight		-28.8 (-57.2,-0.3)
Not reported vs. Severe thinness/thinness/normal weight		12.4 (-10.3,35.1)
Obesity vs. Overweight		38.7 (2.5,74.9)
Obesity vs. Severe thinness/thinness/normal weight		79.9 (47.8,112.0)
Overweight vs. Severe thinness/thinness/normal weight		41.2 (16.4,65.9)

* : Indicates significant Wald χ^2 test.

Notes: The variable listed second is the reference variable.

Abbreviations: AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; B=Beta; CI = 99% confidence interval.

Table 3. Estimates from separate logistic regression models examining self-reported exposure to social media platforms among children and adolescents in six countries (N=9,771).

Parameter	Exposure to Facebook		Exposure to Instagram		Exposure to TikTok		Exposure to Twitter		Exposure to Snapchat		No exposure to social media	
	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)
Country	81.7		17.6		15.2		28.4		13.3		10.0	
AUS vs. CAN		1.28 (1.04,1.56)		0.90 (0.73,1.11)		0.80 (0.64,1.00)		0.92 (0.70,1.20)		0.77 (0.63,0.95)		1.29 (1.01,1.66)
AUS vs. CHILE		0.81 (0.63,1.04)		0.48 (0.37,0.62)		1.41 (1.07,1.86)		0.72 (0.52,0.99)		1.96 (1.50,2.56)		1.72 (1.25,2.36)
AUS vs. MEX		0.23 (0.18,0.30)		0.95 (0.74,1.21)		1.54 (1.15,2.04)		0.37 (0.28,0.50)		1.57 (1.22,2.03)		2.18 (1.57,3.03)
AUS vs. UK		0.89 (0.70,1.14)		0.82 (0.64,1.05)		1.05 (0.80,1.36)		0.54 (0.40,0.73)		0.62 (0.48,0.79)		1.59 (1.16,2.18)
AUS vs. USA		0.84 (0.66,1.06)		1.06 (0.83,1.35)		0.85 (0.66,1.09)		0.60 (0.44,0.81)		0.73 (0.57,0.92)		1.19 (0.89,1.60)
CAN vs. CHILE		0.64 (0.51,0.79)		0.53 (0.43,0.66)		1.76 (1.40,2.22)		0.78 (0.61,1.01)		2.53 (2.02,3.18)		1.33 (1.01,1.75)
CAN vs. MEX		0.18 (0.14,0.22)		1.05 (0.86,1.28)		1.92 (1.51,2.44)		0.41 (0.33,0.51)		2.03 (1.64,2.50)		1.69 (1.27,2.25)
CAN vs. UK		0.70 (0.56,0.87)		0.91 (0.73,1.12)		1.31 (1.04,1.64)		0.59 (0.46,0.76)		0.80 (0.65,0.98)		1.23 (0.93,1.63)
CAN vs. USA		0.66 (0.54,0.80)		1.17 (0.96,1.42)		1.06 (0.87,1.30)		0.65 (0.52,0.82)		0.94 (0.78,1.13)		0.92 (0.72,1.18)
CHILE vs. MEX		0.28 (0.22,0.37)		1.96 (1.54,2.51)		1.09 (0.82,1.46)		0.52 (0.40,0.68)		0.80 (0.61,1.05)		1.27 (0.91,1.78)
CHILE vs. UK		1.10 (0.85,1.42)		1.70 (1.32,2.19)		0.74 (0.56,0.98)		0.75 (0.56,1.01)		0.31 (0.24,0.41)		0.92 (0.66,1.30)
CHILE vs. USA		1.04 (0.81,1.32)		2.19 (1.71,2.80)		0.60 (0.46,0.79)		0.83 (0.63,1.10)		0.37 (0.29,0.48)		0.69 (0.51,0.95)
MEX vs. UK		3.91 (2.99,5.10)		0.86 (0.67,1.11)		0.68 (0.51,0.91)		1.46 (1.11,1.90)		0.39 (0.30,0.51)		0.73 (0.51,1.03)
MEX vs. USA		3.68 (2.86,4.73)		1.11 (0.88,1.42)		0.55 (0.42,0.73)		1.61 (1.25,2.07)		0.46 (0.36,0.59)		0.55 (0.40,0.75)
UK vs. USA		0.94 (0.74,1.20)		1.29 (1.01,1.66)		0.81 (0.63,1.05)		1.11 (0.83,1.46)		1.18 (0.93,1.50)		0.75 (0.54,1.04)
Sex	0.6		69.7		250.4		1.9		26.6		85.3	
Female vs. male		1.04 (0.92,1.18)		1.50 (1.33,1.71)		2.31 (2.02,2.65)		0.92 (0.80,1.07)		1.87 (1.65,2.12)		0.55 (0.47,0.65)
Age	601.2		705.2		30.1		380.7		306.4		588.0	
10-13 years vs. 14-17 years		0.30 (0.26,0.34)		0.27 (0.24,0.30)		1.34 (1.17,1.54)		0.31 (0.27,0.36)		0.37 (0.32,0.42)		6.24 (5.14,7.58)
Ethnicity	0.4		1.5		0.0		2.3		5.2		1.1	
Majority vs. minority		0.96 (0.82,1.13)		0.93 (0.79,1.09)		1.01 (0.85,1.20)		0.90 (0.74,1.08)		0.97 (0.83,1.14)		1.09 (0.88,1.34)
Perceived income adequacy	6.1		2.6		1.3		7.6		1.4		0.1	
Adequate vs. inadequate		0.87 (0.75,1.01)		1.10 (0.95,1.27)		0.93 (0.80,1.09)		1.20 (1.01,1.43)		0.96 (0.83,1.12)		1.02 (0.84,1.23)
School grades	11.1		2.3		10.2		2.1		9.3*		12.3	
High vs. low		0.80 (0.66,0.97)		0.98 (0.81,1.18)		0.73 (0.60,0.89)		1.20 (0.95,1.51)		0.83 (0.69,1.00)		1.42 (1.11,1.82)
High vs. mid		0.78 (0.68,0.90)		0.89 (0.78,1.03)		0.82 (0.71,0.96)		1.03 (0.88,1.21)		0.82 (0.72,0.95)		1.35 (1.13,1.61)
Low vs. mid		0.98 (0.81,1.18)		0.92 (0.76,1.11)		1.13 (0.93,1.38)		0.86 (0.68,1.08)		0.99 (0.82,1.19)		0.95 (0.74,1.22)
BMI	12.1		7.8		3.0		4.1		10.8		12.8	
Not reported vs. Obesity		0.64 (0.50,0.81)		0.74 (0.58,0.94)		0.78 (0.61,1.00)		0.77 (0.58,1.02)		0.71 (0.56,0.90)		1.86 (1.38,2.52)
Not reported vs. Overweight		0.72 (0.59,0.89)		0.74 (0.61,0.90)		0.85 (0.69,1.05)		0.78 (0.61,0.98)		0.69 (0.56,0.84)		1.59 (1.24,2.04)
Not reported vs. Severe thinness/thinness/normal weight		0.93 (0.79,1.10)		0.76 (0.65,0.90)		0.95 (0.80,1.13)		0.94 (0.77,1.15)		0.72 (0.61,0.85)		1.32 (1.09,1.62)
Obesity vs. Overweight		1.13 (0.88,1.45)		1.00 (0.78,1.28)		1.09 (0.84,1.41)		1.02 (0.77,1.35)		0.97 (0.76,1.24)		0.85 (0.62,1.18)
Obesity vs. Severe thinness/thinness/normal weight		1.46 (1.17,1.82)		1.03 (0.83,1.29)		1.22 (0.97,1.53)		1.23 (0.96,1.59)		1.02 (0.82,1.26)		0.71 (0.53,0.95)
Overweight vs. Severe thinness/thinness/normal weight		1.28 (1.08,1.53)		1.03 (0.87,1.23)		1.12 (0.93,1.34)		1.21 (1.00,1.48)		1.05 (0.88,1.24)		0.83 (0.66,1.05)

Notes : The variable listed second is the reference variable.
Abbreviations : AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; CI = 99% confidence interval.

Table 4. Estimates from separate logistic regression models examining daily self-reported exposure to sugary beverage and fast food advertisements among children and adolescents in six countries on a weekday (N=9171).

Parameter	Daily exposure to sugary drinks ads		Daily exposure to fast food ads	
	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)
Country	70.4*		24.3*	
AUS vs. CAN		0.89 (0.69,1.15)		0.89 (0.72,1.10)
AUS vs. CHILE		0.37 (0.28,0.49)		1.11 (0.86,1.43)
AUS vs. MEX		0.29 (0.22,0.38)		0.90 (0.70,1.15)
AUS vs. UK		1.77 (1.26,2.50)		2.00 (1.52,2.62)
AUS vs. USA		0.62 (0.47,0.81)		0.67 (0.52,0.84)
CAN vs. CHILE		0.41 (0.33,0.52)		1.24 (1.00,1.54)
CAN vs. MEX		0.33 (0.27,0.41)		1.00 (0.82,1.23)
CAN vs. UK		1.99 (1.47,2,70)		2.24 (1.76,2.84)
CAN vs. USA		0.69 (0.56,0.86)		0.75 (0.62,0.90)
CHILE vs. MEX		0.79 (0.62,1.00)		0.81 (0.63,1.03)
CHILE vs. UK		4.80 (3.46,6.67)		1.80 (1.36,2.39)
CHILE vs. USA		1.67 (1.30,2.14)		0.60 (0.47,0.76)
MEX vs. UK		6.07 (4.39,8.39)		2.23 (1.69,2.94)
MEX vs. USA		2.11 (1.66,2.68)		0.74 (0.59,0.94)
UK vs. USA		0.35 (0.25,0.48)		0.33 (0.26,0.43)
Sex	1.5		0.4	
Female vs. male		1.07 (0.93,1.23)		1.03 (0.91,1.17)
Age	0.0		1.2	
10-13 years vs. 14-17 years		1.00 (0.86,1.16)		0.95 (0.83,1.08)
Ethnicity	0.1		0.0	
Majority vs. minority		1.02 (0.85,1.23)		1.00 (0.85,1.18)
Perceived income adequacy	1.0		4.5	
Adequate vs. inadequate		0.94 (0.80,1.11)		0.88 (0.76,1.03)
School grades	0.4		3.2	
High vs. low		0.93 (0.75,1.17)		0.95 (0.79,1.15)
High vs. mid		0.96 (0.82,1.13)		0.87 (0.76,1.00)
Low vs. mid		1.03 (0.83,1.29)		0.92 (0.76,1.11)
BMI	6.3*		6.4*	
Not reported vs. Obesity		0.73 (0.56,0.95)		0.75 (0.59,0.94)
Not reported vs. Overweight		0.70 (0.56,0.88)		0.75 (0.61,0.92)
Not reported vs. Severe thinness/thinness/normal weight		0.79 (0.66,0.96)		0.78 (0.66,0.93)
Obesity vs. Overweight		0.96 (0.74,1.25)		1.01 (0.79,1.28)
Obesity vs. Severe thinness/thinness/normal weight		1.09 (0.86,1.38)		1.05 (0.85,1.30)
Overweight vs. Severe thinness/thinness/normal weight		1.14 (0.94,1.38)		1.04 (0.88,1.24)
Exposure to screen based media (weekday)	88.2*	1.05 (1.04,1.07)	121.4*	1.05 (1.04,1.07)

* Indicates significant Wald χ^2 test.

Note : The variable listed second is the reference variable. Exposure to screen based media is expressed in minutes.

Abbreviations: AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; CI = 99% confidence interval.

FIGURES

Figure 1. Mean hours of total screen time (including Youtube, social media, television, playing games and browsing) on a weekday among children and adolescents in six countries after winsorization (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

Figure 2. Percentage of children and adolescents in six countries using platforms of social media (Facebook; Instagram; TikTok; Twitter; Snapchat; None) (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

Figure 3. Percentage of children and adolescents in six countries self-reporting exposure to marketing for unhealthy foods or drinks in three locations (TV shows, series or movies; Website or social media; Video or computer games) in the last 30 days (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

Figure 4. Percentage of children and adolescents in six countries self-reporting daily exposure to marketing for sugary drinks and fast food in the last 30 days (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

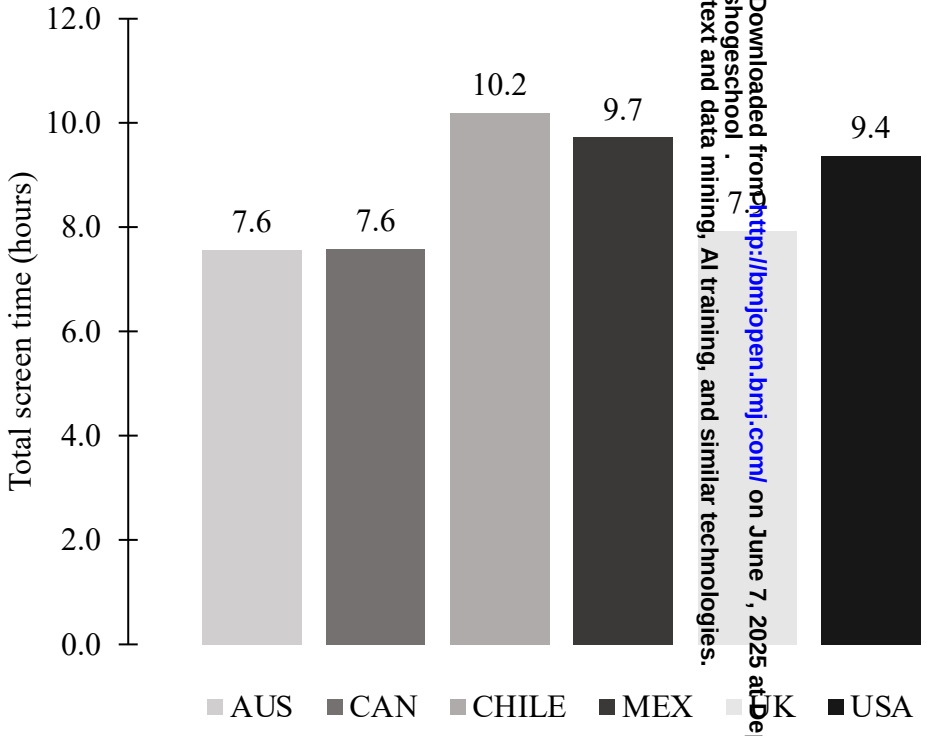

Figure 1. Mean hours of total screen time (including Youtube, social media, television, playing games and browsing) on a weekday among children and adolescents in six countries after winsorization (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

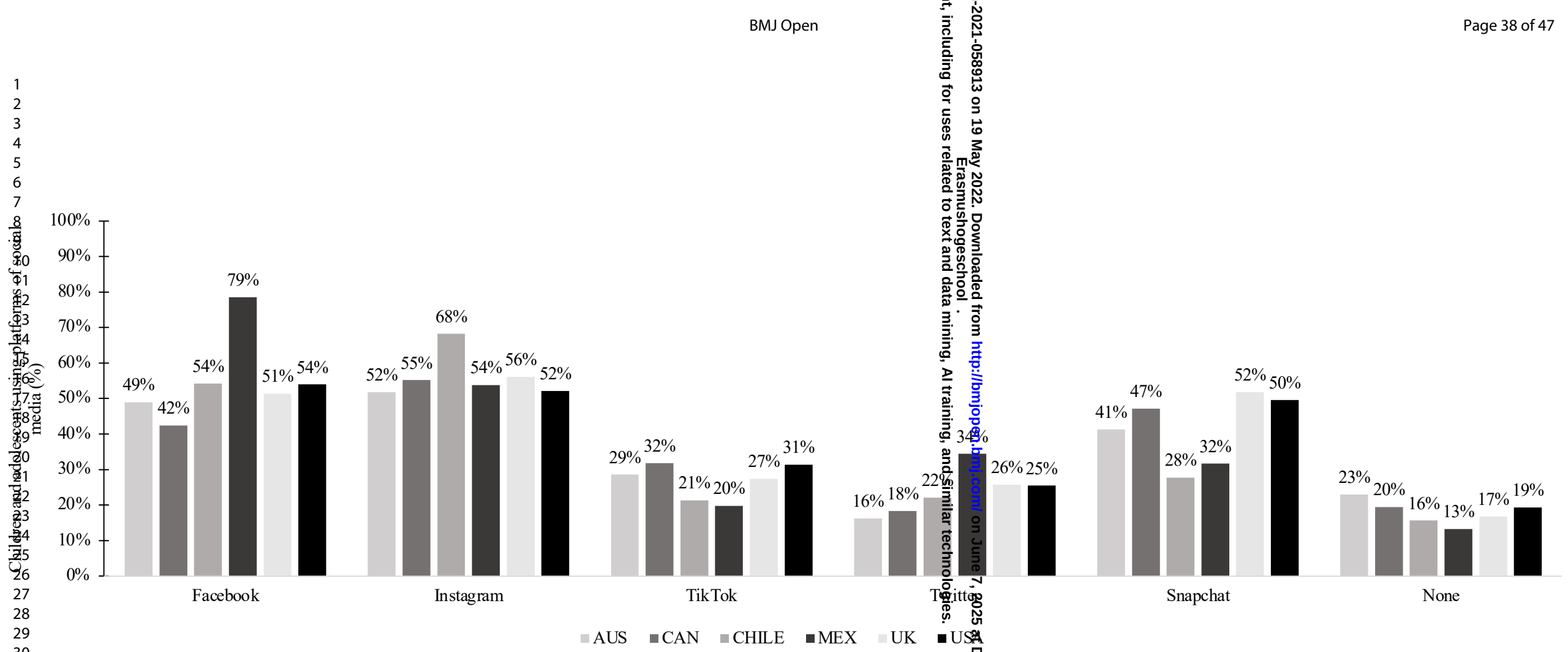

Figure 2. Percentage of children and adolescents in six countries using platforms of social media (Facebook; Instagram; TikTok; Twitter; Snapchat; None) (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

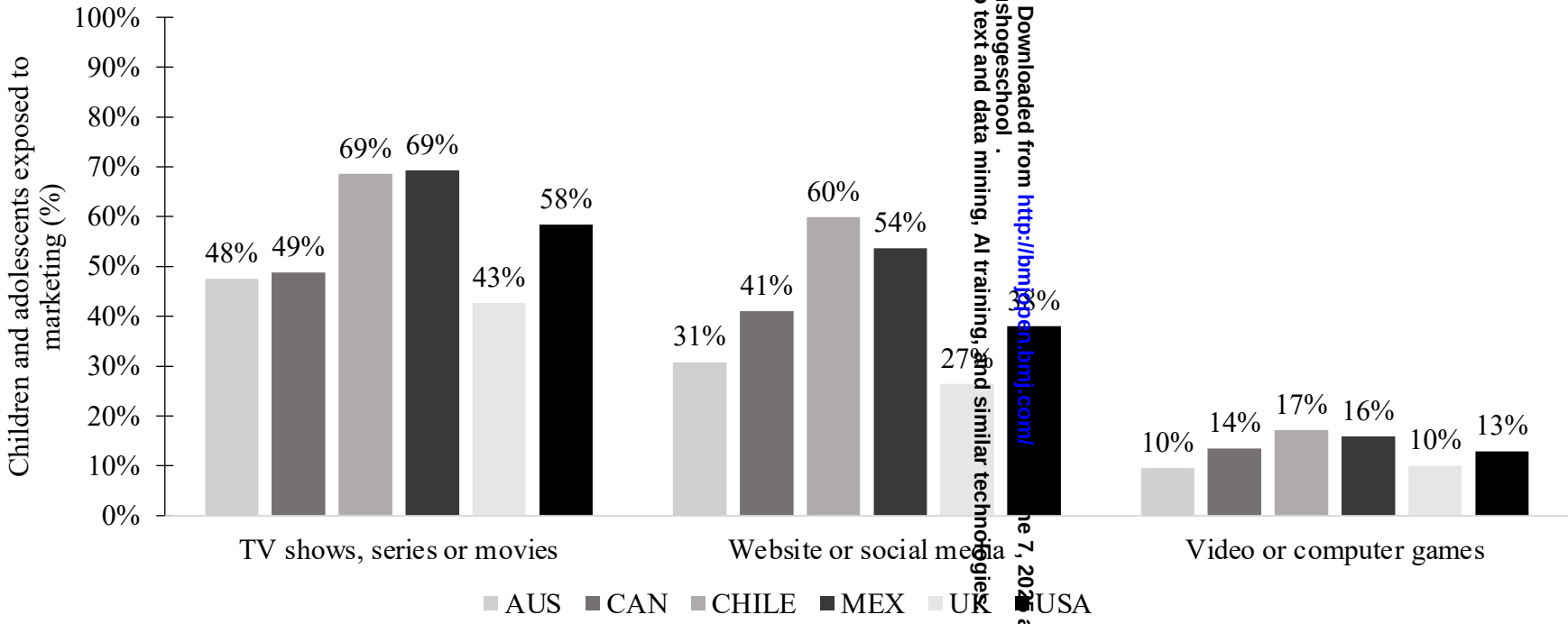

Figure 3. Percentage of children and adolescents in six countries self-reporting exposure to marketing for unhealthy foods or drinks in three locations (TV shows, series or movies; Website or social media; Video or computer games) in the last 30 days (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

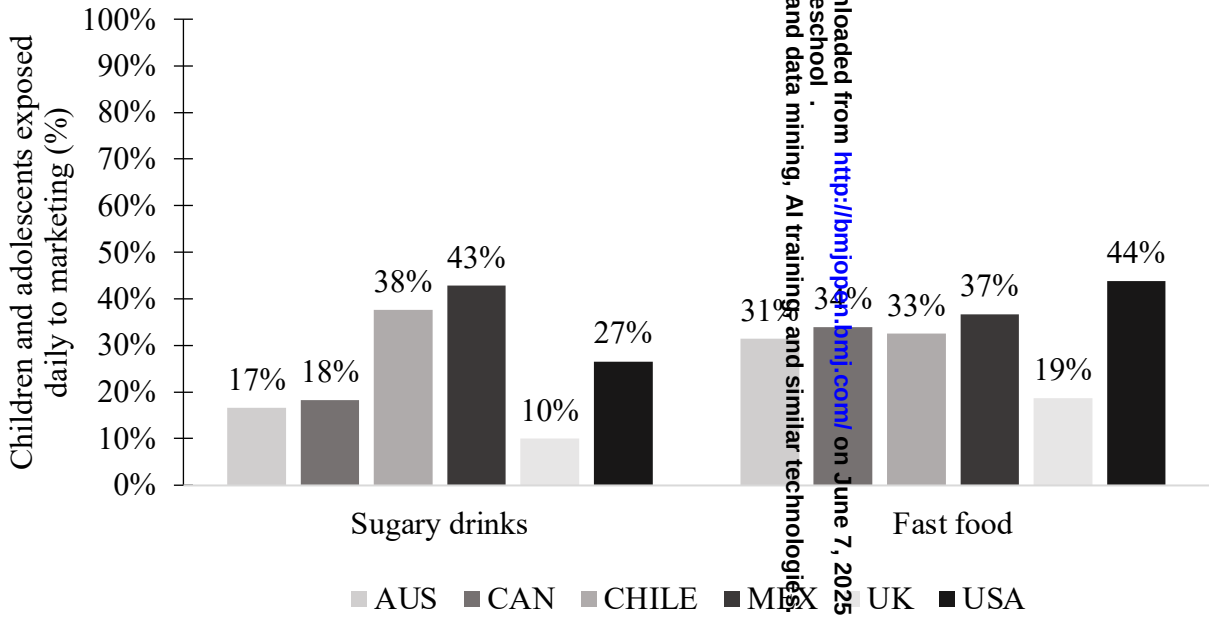

Figure 4. Percentage of children and adolescents in six countries self-reporting daily exposure to marketing for sugary drinks and fast food in the last 30 days (N=9171).

Abbreviations: AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

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Supplementary Table S1. Estimates from separate linear regression models examining the amount of self-reported exposure to screen-based media (in minutes) on a weekend day among children and adolescents in six countries (N=9171).

Parameter	Weekend day screen time	
	Wald χ^2	B (CI)
Country	47.0*	
AUS vs. CAN		-6.8 (-35.7,22.0)
AUS vs. CHILE		-136.9 (-173.8,-100.0)
AUS vs. MEX		-130.0 (-165.4,-94.7)
AUS vs. UK		-26.7 (-60.8,7.4)
AUS vs. USA		-85.6 (-120.1,-51.1)
CAN vs. CHILE		-130.1 (-161.3,-98.8)
CAN vs. MEX		-123.2 (-152.1, -94.2)
CAN vs. UK		-19.8 (-48.7,9.0)
CAN vs. USA		-78.8 (-107.0,-50.6)
CHILE vs. MEX		6.9 (-29.7,43.5)
CHILE vs. UK		110.2 (73.4,147.1)
CHILE vs. USA		51.3 (14.5,88.1)
MEX vs. UK		103.3 (68.2,138.5)
MEX vs. USA		44.4 (9.6,79.2)
UK vs. USA		-58.9 (-93.8,-24.1)
Sex	15.0*	
Female vs. male		-27.0 (-44.9,-9.0)
Age	167.5*	
10-13 years vs. 14-17 years		-90.3 (-108.3,-72.4)
Ethnicity	13.0*	
Majority vs. minority		-32.9 (-56.3,-9.4)
Perceived income adequacy	32.0*	
Adequate vs. inadequate		-47.2 (-68.8,-25.7)
School grades	30.7*	
High vs. low		-79.7 (-106.7,-52.6)
High vs. mid		-35.8 (-55.6,-16.1)
Low vs. mid		43.8 (16.9,70.7)
BMI	10.7*	
Not reported vs. Obesity		-66.2 (-100.0,-32.4)
Not reported vs. Overweight		-20.6 (-48.6,7.4)
Not reported vs. Severe thinness/thinness/normal weight		-2.0 (-25.2,21.1)
Obesity vs. Overweight		45.6 (10.8,80.4)
Obesity vs. Severe thinness/thinness/normal weight		64.2 (32.9,95.5)
Overweight vs. Severe thinness/thinness/normal weight		18.6 (-5.9,43.0)

* : Indicates significant Wald χ^2 test.

Notes : The variable listed second is the reference variable.

Abbreviations : AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; B=Beta; CI = 99% confidence interval.

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Children's and adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing

Supplementary Table S2. Estimates from separate logistic regression models examining daily self-reported exposure to sugary beverage and fast food advertisements among children and adolescents in six countries on a weekend day (N=9171).

Parameter	Daily exposure to sugary drinks ads		Daily exposure to fast food ads	
	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)
Country	70.2*		24.8*	
AUS vs. CAN		0.88 (0.69,1.13)		0.88 (0.72,1.09)
AUS vs. CHILE		0.37 (0.28,0.49)		1.11 (0.86,1.44)
AUS vs. MEX		0.29 (0.22,0.39)		0.91 (0.71,1.17)
AUS vs. UK		1.78 (1.26,2.52)		2.02 (1.54,2.65)
AUS vs. USA		0.61 (0.47,0.81)		0.66 (0.52,0.84)
CAN vs. CHILE		0.42 (0.33,0.52)		1.26 (1.01,1.57)
CAN vs. MEX		0.33 (0.27,0.41)		1.03 (0.84,1.27)
CAN vs. UK		2.02 (1.49,2.75)		2.29 (1.80,2.90)
CAN vs. USA		0.70 (0.56,0.86)		0.75 (0.62,0.91)
CHILE vs. MEX		0.80 (0.63,1.02)		0.82 (0.64,1.05)
CHILE vs. UK		4.86 (3.50,6.76)		1.81 (1.37,2.40)
CHILE vs. USA		1.67 (1.30,2.15)		0.59 (0.47,0.76)
MEX vs. UK		6.08 (4.40,8.40)		2.22 (1.68,2.92)
MEX vs. USA		2.09 (1.64,2.66)		0.73 (0.58,0.92)
UK vs. USA		0.34 (0.25,0.48)		0.33 (0.25,0.43)
Sex	1.3		0.3	
Female vs. male		1.07 (0.92,1.23)		1.03 (0.91,1.17)
Age	0.0		0.7	
10-13 years vs. 14-17 years		1.01 (0.87,1.17)		0.96 (0.84,1.09)
Ethnicity	0.0		0.0	
Majority vs. minority		1.02 (0.85,1.23)		1.00 (0.85,1.18)
Perceived income adequacy	0.5		3.1	
Adequate vs. inadequate		0.95 (0.81,1.13)		0.90 (0.78,1.05)
School grades	0.1		2.7	
High vs. low		0.96 (0.77,1.20)		0.98 (0.81,1.19)
High vs. mid		0.98 (0.84,1.15)		0.89 (0.77,1.02)
Low vs. mid		1.02 (0.81,1.27)		0.90 (0.74,1.09)
BMI	6.3*		6.0*	
Not reported vs. Obesity		0.74 (0.57,0.96)		0.76 (0.60,0.96)
Not reported vs. Overweight		0.70 (0.56,0.87)		0.75 (0.61,0.92)
Not reported vs. Severe thinness/thinness/normal weight		0.81 (0.66,0.98)		0.79 (0.67,0.94)
Obesity vs. Overweight		0.94 (0.72,1.23)		0.99 (0.78,1.26)
Obesity vs. Severe thinness/thinness/normal weight		1.09 (0.86,1.38)		1.05 (0.85,1.30)
Overweight vs. Severe thinness/thinness/normal weight		1.16 (0.96,1.40)		1.06 (0.89,1.27)
Exposure to screen based media (weekend day)	128.7*	1.06 (1.05,1.08)	186.5*	1.07 (1.06,1.08)

Abbreviations : CAN=Canada, AUS=Australia, MEX=Mexico, UK=United Kingdom, USA=United States of America; CI = 99% confidence interval.

* : Indicates significant Wald χ^2 test.

Notes : The variable listed second is the reference variable. Exposure to screen based media is expressed in minutes.

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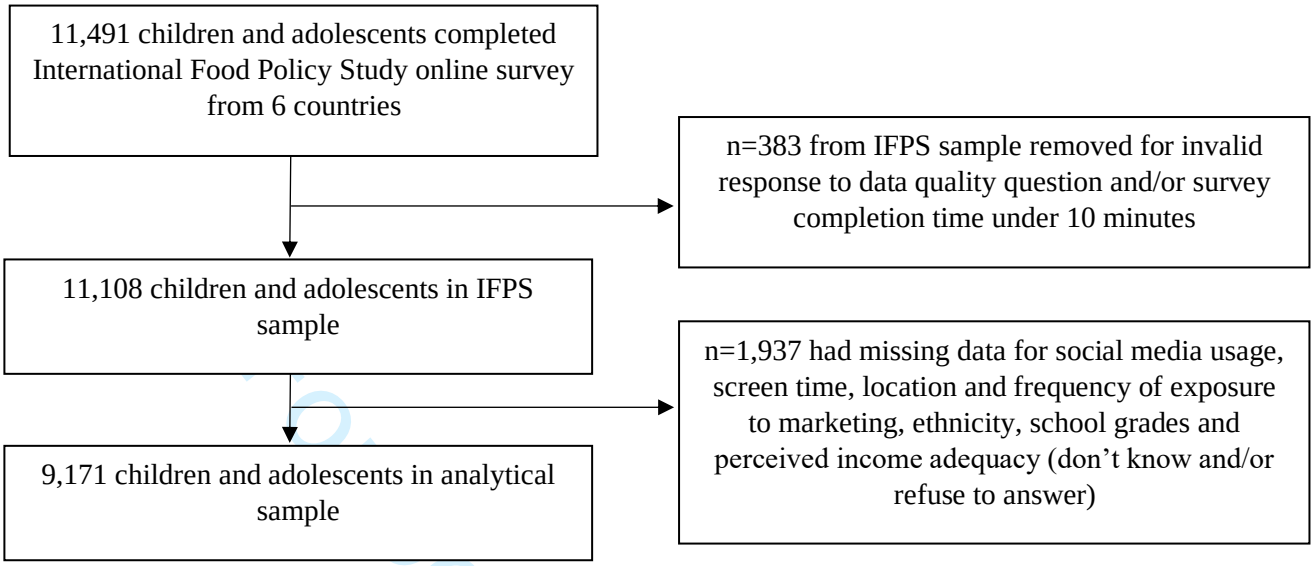

Supplementary Figure S1. Flow chart of participants included in the analytical sample.

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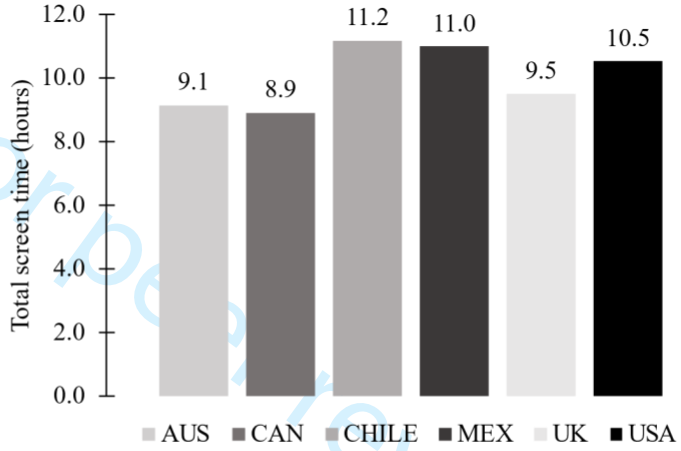

Supplementary Figure S2. Mean hours of total screen time (including Youtube, social media, television, playing games and browsing) on a weekend day among children and adolescents in six countries after winsorization (N=9171).
Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

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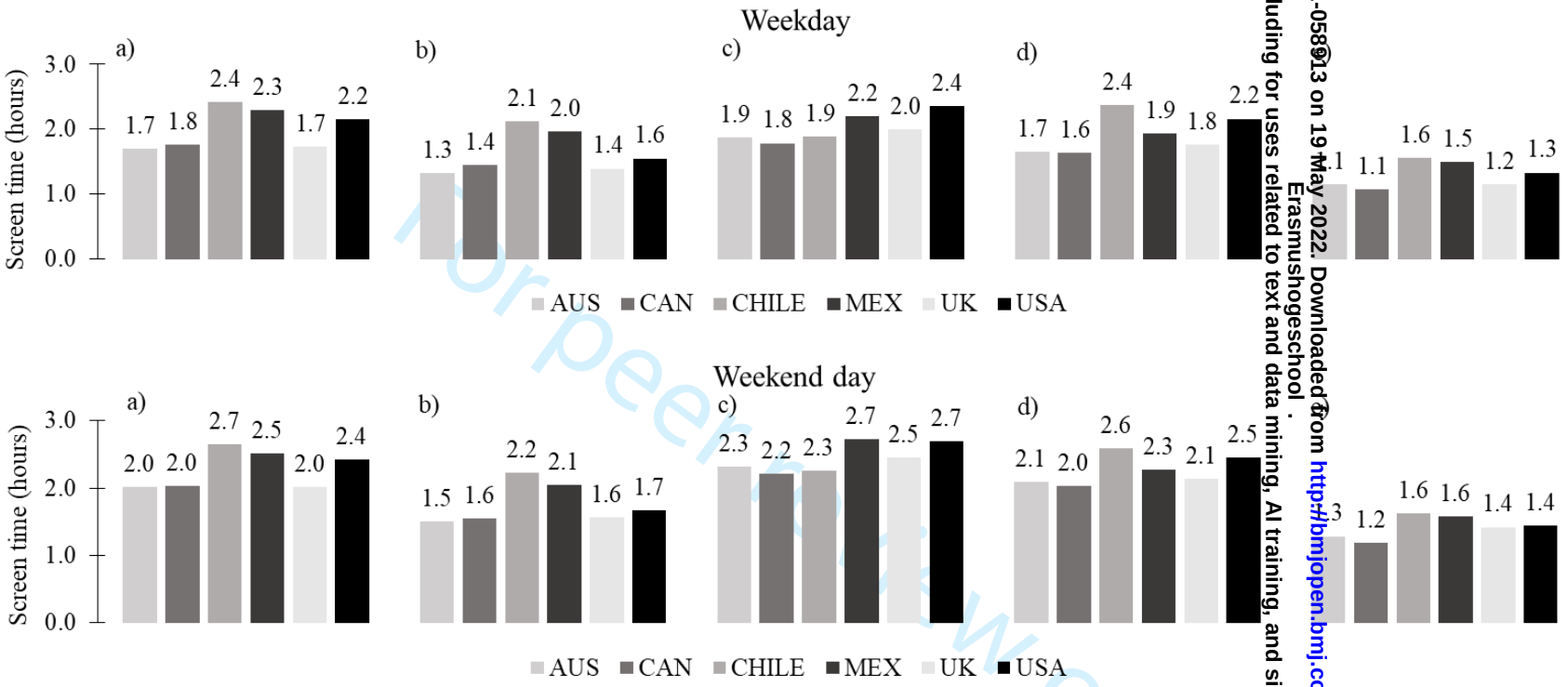

Supplementary Figure S3. Mean amount of screen time (in hours) for five media channels on a weekday (above) and weekend day (below) among children and adolescents in six countries before winsorization (N=9171).
a) Watching YouTube
b) On social media (including messaging, posting, or liking posts)
c) Watching TV shows, series, or movies
d) Playing games on smartphones, computers, or game consoles
e) Browsing, reading websites, Googling, etc.
Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

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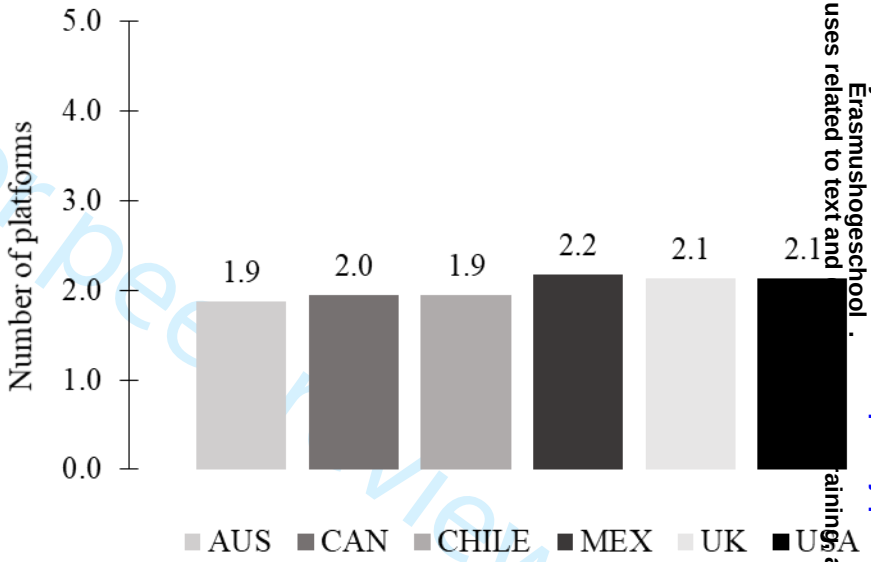

Supplementary Figure S4. Mean number of social media platforms used among children and adolescents in six countries (N=9171) [a].
Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.
[a] Range of 0 to 5 possible social media platforms.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	11
Study size	10	Explain how the study size was arrived at	12
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-13
		(*b*) Describe any methods used to examine subgroups and interactions	13
		(*c*) Explain how missing data were addressed	12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	13
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	12
		(c) Consider use of a flow diagram	12
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	12, SFig 1
Outcome data	15*	Report numbers of outcome events or summary measures	14-16
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 3

		(*b*) Report category boundaries when continuous variables were categorized	13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	23-24
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-22
Generalisability	21	Discuss the generalisability (external validity) of the study results	24-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing

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Adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing

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Abbreviations

IFPS : International Food Policy Study

UK : United Kingdom

USA : United States of America

Word count : 5780

ABSTRACT

Objectives: The study objectives were to examine: 1) adolescents' media viewing habits; 2) associations with media viewing and self-reported exposure to unhealthy food and beverage advertising; and 3) differences in trends among younger and older adolescents in six high and upper-middle income countries.

Design: Repeat cross-sectional online survey.

Setting: Australia, Canada, Chile, Mexico, the United Kingdom (UK) and the United States (USA).

Participants: Respondents to the International Food Policy Study (IFPS) who provided information on all variables of interest in November-December 2019 aged 10 to 17 years (n=9171).

Outcome measures: Self-reported exposure to screen-based media (screen time by media channel), use of social media platforms, and self-reported location and frequency of exposure to unhealthy food and beverage advertising.

Results: The average amount of time spent in front of various screens ranged from 7.6 hours to 10.2 hours across countries per weekday, which may include possible viewing of multiple media channels simultaneously. Overall, Instagram was the most popular social media platform (52-68% by country), followed by Facebook (42-79%) and Snapchat (28-52%). The percentage of respondents who self-reported having seen unhealthy food advertisements in the past 30 days was highest on television (43-69%), followed by digital media (27-60%) and gaming applications (10-17%). Self-reported daily exposure to advertising varied between countries for sugary drinks (10-43%) and fast food (19-44%), and was positively associated with self-reported screen time. Self-reported

exposure to screen-based media and social media platforms differed by socio-demographic characteristics, and was higher among older adolescents than younger adolescents.

Conclusions: The large percentages of adolescents across all countries who report viewing screen-based media and social media usage, and high rates of self-reported advertising exposure, support the need for policies to restrict marketing of unhealthy food and beverages appealing to adolescents on screen-based media.

Keywords: Food marketing; food policy; marketing to children; broadcast media; digital media; adolescents; food environment

Article summary

Strenghts and limitations of this study

- The study has a large sample size, and employs the same measures across countries, allowing justifiable comparisons between countries.
- Assessed self-reported exposure to a wide range of social media platforms, and differentiated locations of self-reported exposure to screen-based advertisements.
- Adolescents retrospectively self-reported the estimated screen time spent on each media channel rather than using a more objective approach.
- Self-reported exposure to marketing may result in an underestimation of exposure to marketing, and this study provides a conservative estimate.
- Time spent watching cable television vs. on streaming applications (Netflix, Crave, Amazon Prime Video, etc.) was not distinguished in this study.

1. Introduction

In recent decades, children and adolescents have become the targets of a variety of marketing techniques, many of which exploit their vulnerabilities. Children are most often not able to recognize the persuasive intent of marketing and may perceive it as entertainment, making them particularly susceptible to marketing content (1). Children and adolescents are a potentially important market segment, as effective marketing towards them can build early positive associations, create life-long consumers and brand relationships that extend into adulthood (2, 3). As such, the WHO and others have called for restrictions on marketing to children and younger adolescents of specific products (such as tobacco or vaping products and unhealthy foods or beverages) (4). Some jurisdictions, such as the province of Quebec (Canada), the UK, Chile and Mexico have implemented policies restricting unhealthy food marketing targeted at children and younger adolescents typically 13 years and under (5), as it is well established that food marketing influences children's and adolescents' dietary preferences for products, consumption patterns, and shapes their purchasing behavior as well as their purchase requests to parents (6-9).

Effective food marketing depends on both exposure (defined as the number of people seeing the message and the frequency to which the person is exposed to the message) and power (defined as the "creative content, design and execution of the marketing message"), which both vary considerably between media channels or types (4, 10). Various marketing techniques are used across media channels to optimize the effectiveness of marketing (8, 11-14), and may differ both in their impact on children and adolescents as well as whether or not children and adolescents can recognize them as

marketing (15, 16). Screen-based media, which for the large part includes television, digital media (including social media) and gaming sites, all have different implications with regard to the exposure and power of marketing messages that reach their audience.

Companies are increasingly using digital platforms as a complement to traditional advertising on television in a mixed-media approach to maximize the reach, efficiency and effectiveness of marketing (17, 18). Globally, time spent online on social media, gaming, streaming, and browsing the web is significant, and appears to be increasing in some countries (19, 20), representing an important channel for advertising energy dense and nutrient-poor products (21-25). Given the shifting media consumption habits of children and adolescents, exploration of media consumption and associations with exposure to marketing of less healthy food products, and their patterning by demographic and socio-economic factors is warranted. Most studies to date that examine media consumption habits among children and adolescents have been limited to a single media type, and do not examine exposure across multiple countries. This study aimed to explore adolescents' media consumption habits (self-reported screen time and use of social media platforms) and associations with self-reported exposure to unhealthy food and beverage advertisements (location and frequency) across six high and upper-middle income countries (Australia, Canada, Chile, Mexico, UK and USA). As a secondary objective, the study aimed to examine differences in trends among younger adolescents (10-13 years) and older adolescents (14-17 years), the latter of which often fall outside the purview of policies restricting marketing of unhealthy food and beverages.

2. Subjects and methods

Data are from the 2019 International Food Policy Study (IFPS) Youth Survey, an annual repeat cross-sectional survey conducted in Australia, Canada, Chile, Mexico, the UK and the USA. Data were collected via self-completed, web-based surveys conducted in November-December 2019 with adolescents aged 10 to 17 years. According to the World Health Organization (WHO), the period of adolescence is between 10 and 19 years of age (26); participants will henceforth be referred to as younger adolescents (ages 10-13) and older adolescents (14-17). Respondents were recruited through parents/guardians enrolled in the Nielsen Consumer Insights Global Panel and their partners' panels. Email invitations with unique survey links were sent to adult panelists within each country. Those who confirmed they had a child aged 10 to 17 living in their household were asked for permission for their child to complete the survey (only one child per household was invited). Adolescents aged 10 to 17 years were eligible to participate, with quotas for age and sex groups in the UK and USA. After eligibility screening, all potential respondents were provided with information about the study and asked to provide assent. Surveys were conducted in English in Australia and the UK; Spanish in Chile and Mexico; English or French in Canada; and English or Spanish in the USA. Members of the research team who were native in each language reviewed the French and Spanish translations independently. The median survey time was 24 minutes.

The child's parent/guardian received remuneration in accordance with their panel's usual incentive structure (e.g., points-based or monetary rewards, chances to win prizes). A full description of the study methods can be found in the International Food Policy Study: Technical Report – 2019 Youth Survey at http://foodpolicystudy.com/methods/ (27).

2.1 Total screen time and screen time by media channel and activity

Self-reported daily screen time was measured using the question: "*On a normal weekday, how much time do you spend…?*" Participants were asked to answer this question for five different media channels and/or activities: YouTube, social media (including messaging, posting, or liking posts); TV (shows, series, or movies); playing games (on smartphones, computers, or game consoles); and browsing (reading websites, Googling, etc.). Responses for amount of screen time for each media channel were captured using a scale (none; up to 15 minutes; up to 30 minutes; up to 1 hour; up to 2 hours; up to 3 hours; up to 4 hours; more than 4 hours; don't know; refuse to answer). The same question was presented afterwards for a "normal weekend day". Although the phrasing "up to" means that participants could have watched less than the stated value, the ceiling value was used to calculate an estimated amount of time in minutes spent on each media channel and all channels combined. For example, up to 15 minutes was recoded as 15 minutes, and up to 1 hour was recoded as 60 minutes. Those who responded "more than 4 hours" were recoded as 300 minutes (i.e., 5 hours). As adolescents could have been viewing multiple media channels simultaneously, the sum of exposure (i.e., total minutes across all media types) was used as an overall indicator of total amount of exposure to screen-based media. Winsorization was used to limit the effect of extreme values on total screen time . The maximum amount of total screen time was set at the mean + 2 SD, in this case 1195 minutes for a weekday and 1268 minutes for a weekend day. Participants (n=572, weekday (6.2%) and n=432, weekend day (4.7%)) who exceeded this value had their total screen time decreased to the maximum. The winsorization technique yielded a slightly higher cutoff (+73 minutes) for weekends,

as might be expected. The maximum amount obtained using this method was compared with a hypothetical estimation based on an assumption that on a weekday, children and adolescents spend roughly 7 hours at school and 8 hours sleeping, which sums up to 15 hours. It is plausible that there may have been some screen time during school hours that would fall within the aforementioned categories (browsing or watching YouTube), and so it was assumed that this was approximately 1 hour. The total (14 hours) was subtracted from the length of a day (24 hours) to give a possible maximum of 10 hours of screen time, with a maximum of 20 hours if two screens were being used simultaneously. This estimation of 20 hours (1200 minutes) confirms the measure of total maximal screen time for weekdays (1195 minutes) and weekends (1268 minutes) has good face-validity.

2.2 Usage of social media platforms

Self-reported usage of various social media platforms was assessed using the measure: "*Do you use…? (select all that apply)*" (Response options: "Facebook", "Instagram", "TikTok", "Twitter", "Snapchat", "none of the above", "don't know" or "refuse to answer").

2.3 Self-reported location of exposure to unhealthy food and beverage advertisements

Self-reported location of exposure to advertisements was assessed using the question: "*Have you seen or heard advertisements for "unhealthy" foods or drinks in any of these places in the last 30 days?*" Participants were instructed "*Unhealthy food and drinks include processed foods high in sugar, salt, or saturated fat, such as soda/pop, fast food, chips, sugary cereals, cookies and chocolate bars.*" Participants could select all the responses that applied from a list of 13 potential media channels, and an 'other' option

with an open-text box, or "I haven't seen any ads for unhealthy food in the last 30 days", "don't know" or "refuse to answer." In this study, three channels were analyzed that pertain to screen-based media (television shows, series or movies; website or social media; and video or computer games). Open text data were reviewed, and responses were re-coded to be included as one of the categorical options as applicable. "YouTube" and "social media" were recoded to be included in the category "website or social media" and "TV" was recoded in the category of television shows. When participants wrote "all" in the open text, these responses were coded in each category of advertisement location.

2.4 Self-reported frequency of exposure to unhealthy food and beverage advertisements

Self-reported frequency of exposure to unhealthy food and beverage advertisements was assessed using the question: "*In the last 30 days, how often did you see or hear advertisements for these kinds of food or drinks*?" Participants responded for advertisements for six food categories, two of which were included in this analysis (sugary drinks; fast food from a restaurant). The frequency was assessed using a likert-type scale. (Response options: "never", "less than once a week", "once a week", "a few times a week", "everyday", "more than once a day", "don't know" and "refuse to answer"). Frequency of exposure was then recoded as a binary variable, where "everyday" and "more than once a day" were combined as "daily", and the other options combined as "less than once a day"; responses of "don't know" or "refused" were considered as missing.

2.5 Socio-demographic measures

Socio-demographic data included age, ethnicity, sex, country, school grades and perceived income adequacy. Age was included as a binary variable (younger adolescents aged 10 to 13 years, and older adolescents aged 14 to 17 years). Ethnicity was assessed using unique measures from each country and recoded to derive comparable measures across countries: *majority* or *minority* ethnicity. Participant's sex was self-reported by asking "*Are you…"* with responses "male" or "female". School grades were measured using the question: "*What grades do you usually get in school?*" Response options varied across countries and were recoded to derive comparable measures across countries and three groups were created: "low" (<grade of B in most countries), "mid" (grade of B in most countries) or "high" grades (grade of A in most countries). Perceived income adequacy was examined using the measure: "*Does your family have enough money to pay for things your family needs*?" (Response options: "not enough money", "barely enough money", "enough money", "more than enough money", "don't know" and "refuse to answer"). Perceived income adequacy was recoded as a binary variable, (not enough money/barely enough money were combined as "inadequate" and enough money/more than enough money were combined as "adequate"); responses of "don't know" or "refused" were considered as missing and excluded from analyses. Participant's body mass index (BMI) was calculated using self-reported height and weight. BMI was assessed using z-scores and classified according to the WHO recommendations (28). *Severe thinness, thinness* and *normal weight* were combined considering low levels of respondents for the *severe thinness and thinness* category (All countries = 2.9%, Australia = 3.3%, Canada = 4.2%, Chile = 0.9%, Mexico = 1.7%, UK = 2.8%, US = 3.0%). Extreme values were recoded as missing (z-score < -5 or > 5) according to the

WHO growth reference guidelines (29). Extreme values as well as those participants whose height and/or weight were missing were coded as "not reported" and included in the analytic sample to reduce bias as potentially important differences between those who do not report their height and weight in population-level surveys have been identified (30). A full list of measures in each country is available at http://foodpolicystudy.com/methods/ in the surveys section (31). The questionnaire has not been validated, but cognitive testing among a subsample of English-speaking adolescents for various questions including screen time and exposure to advertisements has been conducted to verify their understanding. When necessary, questions were adapted to improve comprehension (unpublished data).

2.6 Data analysis

A total of 11,491 adolescents completed the survey. Respondents were excluded for the following reasons: region was missing, ineligible or had an inadequate sample size (i.e., Canadian territories); invalid response to a data quality question; and/or survey completion time under 10 minutes (n=383). The analytic sample included 11,108 respondents (Australia: n=1,435; Canada: n=3,682; Chile: n=1,252; Mexico: n=1,616; UK: n=1,520; USA: n=1,603). A sub-sample (n=9,171) was included in the current analysis after excluding respondents with missing data (including don't know and refuse to answer) for social media usage, screen time, location and frequency of exposure to unhealthy food and beverage advertisements, ethnicity, school grades and perceived income adequacy (**Supplementary Figure S1)**. Data were weighted with post-stratification sample weights constructed using a raking algorithm with population

estimates from the census in each country based on age group, sex, region, and ethnicity (except in Canada). Reported estimates are weighted.

Descriptive statistics were tabulated including the self-reported mean number of hours viewing screen-based media across all channels and by channel on a weekday and weekend day, the self-reported usage of each social media platform and mean number of social media platforms (maximum of 5 platforms), the self-reported frequency of the three advertisement locations and the percentage of respondents reporting being exposed daily to advertisements for sugary drinks and fast food by country.

Regression models examined differences in the amount of self-reported exposure to screen-based media between countries and population subgroups. First, linear regressions were conducted with the amount of self-reported exposure to screen-based media (total screen time in minutes) as the dependent variable, including an indicator variable for country and age category (10-13 years, 14-17 years), adjusting for sex, ethnicity, perceived income adequacy, school grades, and BMI. Next, separate logistic regression models were conducted for each social media type (1=yes, 0=no), including an indicator variable for country and age category, and adjusting for the same variables listed above. Lastly, separate logistic regression analyses were used to examine associations between the self-reported exposure to screen-based media and self-reported daily exposure to advertisements for each of the food categories (sugary drinks; fast food from a restaurant), with self-reported daily exposure to sugary drink or fast food marketing as the dependent variable, including indicator variables for the amount of exposure on a weekday (continuous) and country, adjusting for the same demographic correlates. Separate models were tested for self-reported exposure to screen-based media on

weekends. For all regressions, survey-aware procedures were used to account for finite sampling methods, and 99% confidence intervals are presented due to the use of multiple comparisons. Analyses were conducted using SAS Studio 3.8.

2.7 Patient and public involvement

Patients and the public were not involved in the design, conduct, analysis or interpretation of the study. Study participants could have access to the study results upon request.

3. Results

Weighted sample characteristics are presented in **Table 1**. There were differences between countries in ethnicity group, school grades, perceived income adequacy and BMI. In general, a greater percentage of participants identified as a minority group in the USA, a smaller percentage had high school grades in Australia and the UK, and a greater percentage perceived their family income as adequate in Canada.

3.1 Self-reported exposure to screen-based media

Figure 1 shows the mean amount of total self-reported screen time for a weekday among participants across countries, which ranged from 7.6 hours (Canada and Australia) to 10.2 hours (Chile). Similar findings were observed across countries for a weekend day, but with higher total amounts (**Supplementary Figure S2**). Time spent on various media channels is shown in **Supplementary Figure S3**. Digital media, comprised of YouTube, social media and browsing, reading websites and Googling, was the largest contributor overall. Across all countries, participants in Chile spent the highest amount of time on YouTube, social media, playing games and browsing, while participants in the USA spent the most time watching television on a weekday.

Estimates from a linear regression model examining the total amount of self-reported exposure to screen-based media on a weekday across countries is shown in **Table 2**. Total screen time differed by country, and across all demographic correlates. Participants in Canada and Australia reported less screen time than those in Chile, Mexico and USA; and Chilean participants reported more screen time than those in all other countries except Mexico. Older adolescents spent more time on screens than younger adolescents. The same pattern of results was observed for a weekend day (**Supplementary Table S1**).

3.2 Self-reported social media exposure

The percentage of participants self-reporting using different social media platforms across countries is shown in **Figure 2**. Overall, 77% to 87% of adolescents were using at least one of the social media platforms, which varied by country. On average, the most commonly used platform was Instagram (range: from 52% in Australia and the USA to 68% in Chile), followed by Facebook (range: from 42% in Canada to 79% in Mexico), and Snapchat (range: from 28% in Chile to 52% in the UK). Participants who reported no social media application use ranged from 13% (Mexico) to 23% (Australia). After stratifying self-reported social media usage by age category (**Supplementary Figure S4**), usage was still common among younger adolescents (10-13 years), and TikTok usage was more frequent among 10-13 than 14-17 year old adolescents in all countries. The mean number of social media platforms used per respondent across countries is shown in **Supplementary Figure S5**, and ranged from 1.9 platforms (Australia and Chile) to 2.2 platforms (Mexico).

Estimates from separate logistic regression models examining self-reported exposure to social media platforms across countries are shown in **Table 3** and differed by country

and age group for all platforms. Specifically, participants in Canada were less likely to use Facebook than those in all other countries, whereas participants in Mexico were more likely to use Facebook than those in all other countries. Those in Chile were more likely to use Instagram than those in all other countries. Participants from Canada were more likely to use TikTok than participants in Australia, Chile, Mexico and the UK. Participants in Mexico were more likely to use Twitter than participants in all other countries, and those in the UK were more likely to use Snapchat than those in all other countries except the USA. Participants in Australia were more likely to not use a social media platform compared to all other countries except the USA. Older adolescents (ages 14-17) were more likely to use all social media platforms except TikTok compared to younger adolescents (ages 10-13).

3.3 Location of self-reported screen-based exposure to advertisements for unhealthy foods or drinks

The percentage of adolescents who reported that they were exposed to advertisements for unhealthy foods or drinks in three locations in the previous 30 days is shown in **Figure 3**. Overall, TV shows, series or movies accounted for the largest number of participants self-reporting exposure to advertisements (range: from 43% in the UK to 69% in Mexico and Chile), followed by websites or social media (range: from 27% in the UK to 60% in Chile), and video or computer games (range: from 10% in Australia and the UK to 17% in Chile).

3.4 Self-reported daily exposure to sugary beverage and fast food advertisements

The percentage of respondents who reported that they were exposed daily to advertisements for both food categories in the last 30 days is shown in **Figure 4**. Self-

reported daily exposure to sugary drinks advertisements ranged from 10% (UK) to 43% (Mexico). Self-reported daily exposure to fast food advertisements was relatively more consistent across countries, with the exception of the UK (range: from 19% in the UK to 44% in the USA).

Estimates from separate logistic regression models examining self-reported daily exposure to sugary beverage and fast food advertisements across countries are shown in **Table 4**. Participants who self-reported more time spent on screen-based media were more likely to report daily exposure to advertisements for both food categories. Self-reported daily exposure to advertisements for sugary drinks and fast food differed by country and amount of self-reported exposure to screen-based media (total screen time in minutes), and patterns were mostly similar across both food categories; there was no significant difference in self-reported exposure between age groups. Overall, participants in Mexico and Chile were much more likely to report daily exposure to sugary beverage advertisements than participants in all other countries, with fewer differences for fast food advertisements. Participants in the UK were less likely to report daily exposure to advertisements of sugary drinks and fast food compared to all other countries and those in the USA were more likely to report daily exposure to fast food advertisements than those in all other countries. The same pattern of results was observed for exposure to screen based media on a weekend day (**Supplementary Table S2**).

4. Discussion

Summary of main findings

This study found that adolescents across Australia, Canada, Chile, Mexico, UK and USA are self-reporting considerable amounts of time viewing screen-based media,

although these self-reported estimates include simultaneous viewing of multiple media. Digital media accounted for the most time on screens and social media use varied by platforms. Across all countries, self-reported exposure to advertisements in the past 30 days was most frequent on television, followed by digital media and gaming platforms. Between-country differences were identified: participants in the UK reported less daily exposure to fast food and sugary drinks advertisements, whereas participants in the USA reported greater daily exposure to fast food advertisements. Most importantly, our results show that in all countries, self-reported exposure to advertisements increased with greater screen time. Analyses suggested important differences in self-reported exposure to screen-based media and social media platforms between age groups, with older adolescents generally reporting a greater exposure.

Relationships with existing knowledge

The estimates from this study are similar to other international estimates of self-reported screen time. In the US, screen time among children 8-12 years in 2019 was estimated to be 4 hours 44 minutes, and 7 hours and 22 minutes among 13-18 year olds (32), compared to over 9 hours in the current study among the older age group. A large national Canadian study from 2013-2014 suggests that youth ages 13 to 18 spent on average between 7.6 and 8 hours in front of screens daily (depending on province and sex) (33), very similar to the current findings of approximately 8.5 hours among older adolescents. However, the current estimates appear to be higher than several European estimates from various countries (34), which may be due to differences in the types of questions asked and the study context that may affect recall and self-report. Even with limtations on the precision of screentime estimates due to self-report, most participants

in the current study exceeded screen time guidelines across countries, which recommend entertainment screen time be limited to less than 2 hours daily for school-aged children and adolescents (35-37). Screen time has previously been associated with youth obesity (38, 39), poorer diet quality (40), and consumption of less healthy foods and beverages (41, 42). The general level of exposure reported among the sample, while an approximation, is cause for concern.

The large proportion of adolescents reporting using social media platforms has important implications for food and beverage marketing. Companies are increasingly developing strategies to engage with their audience through these media platforms, which have a high likelihood of reaching children and adolescents even when they are not the primary target audience. Research from Canada has estimated that children ages 7-11 years were exposed to food and beverage marketing (of which the great majority is "less healthy") on social media apps 30 times per week while adolescents ages 12-16 years were exposed on average 189 times per week (23). In our study, adolescents reported using two social media platforms on average, therefore exposing them to various types and amounts of marketing strategies across platforms. For instance, Instagram—the most commonly reported social media platform among participants—is known to promote poor nutritional quality foods and are commonly promoted through popular brand accounts using a range of marketing strategies that appeal to a young audience, such as competitions and the use of characters (43). Unhealthy food brands on Facebook are known to use techniques such as competitions based on user-generated content, interactive games, and apps (44).

In this study, a greater proportion of adolescents reported exposure to advertisements for unhealthy foods or drinks on television compared to websites, social media applications or gaming sites. Greater reporting may be in part due to the different types of advertising between these channels. In order for children and adolescents to be aware of advertisements, they need to be able to identify the difference between an advertisement and other content, but also understand the persuasive intent behind the message (15). Self-reported exposure to advertisements on television may have been higher as it is more easily identifiable compared to digital marketing which often uses subtle marketing techniques (e.g. such as celebrity endorsements by influencers and native advertising designed to imitate editorial content) and is frequently disguised as entertainment (15, 16). On digital media, adolescents may simply be less able to discriminate advertisements from other content, making marketing on these channels particularly alarming. Digital marketing via advertisements is typically targeted, using cookies and other means which record personal preferences, online activity, and location and these data are then used to personalize and target the content of marketing to individual users, therefore increasing the persuasive power of marketing (10, 11). The subtle advertising techniques used on digital media, such as influencer endorsements or advergames may be more likely to bypass children's and younger adolescents' cognitive awareness. Our data align with marketing expenditure data, an objective indicator of marketing efforts by companies: fast-food advertisement expenditures are the highest for television, although digital marketing expenditures increased by 74% between 2012 and 2019 (45). However, digital marketing expenditures are likely underestimated as not all industry spending can be captured and spending is not necessarily associated with the reach of the message on

digital media (46). Therefore, both self-reported exposure data and the general digital marketing expenditure data likely underestimate the amount of digital marketing to which adolescents are currently exposed.

Self-reported daily exposure to advertisements was common for both fast food and sugary drinks, with 34% and 25% of the sample reporting daily exposure, respectively, in all countries. Perhaps unsurprisingly, those reporting more screen time were more likely to report daily exposure to sugary drinks and fast food advertisements. Differences across countries may in part relate to differences in restrictions on marketing directed at children. In the UK, where participants were less likely to self-report daily exposure to advertisements for fast food and sugary drinks than those in all other countries, a total ban of advertisements for unhealthy foods and beverages has been in place since 2007 during and adjacent to television programs appealing to children and adolescents under the age of 16 (47). The lower likelihood of self-reported exposure to advertisements aligns with what would be expected with the UK's current policy in place, although evidence on the impact of the UK policy is mixed. Findings suggest that despite some changes in children's exposure, advertisements typically shifted to other media channels, implying important loopholes in regulations (48, 49). In the USA, where participants were more likely to report daily exposure to fast food advertisements than those in all other countries, voluntary self-regulatory approaches to restrict marketing by the industry are the only form of marketing restrictions, which target children under 12 years of age on media where the audience is mostly children (50), and have largely proven ineffective at decreasing children's exposure to marketing for unhealthy products (45, 51, 52). It is important to note that the present study cannot capture the effectiveness of restrictive

marketing policies by its cross-sectional design, but studying trends in self-reported screen-time, social media use and exposure to advertisements annually over time using the IFPS should help evaluate the impact of impending policies, such as the recently announced policy in the UK which will ban online advertising by the end of 2022 and ban advertising of foods high in fat, sugar and salt between 5:30 am and 9 pm (53-55).

Age group was an important predictor for reported screen-based media and social media exposure, with older adolescents reporting spending more time on screens and using social media platforms more than younger adolescents. Older adolescents may be an age group of particular interest to marketers because of their greater spending power compared to younger adolescents, which also increases with age, therefore having the potential to create life-long brand relationships and product consumers (56, 57). Marketers target adolescents through digital media by using "ubiquitous connectivity, personalization, peer-to-peer networking, engagement, immersion and content creation", which are features especially appealing to this age group (57). In our study, there were no differences in self-reported daily exposure to sugary drink and fast food advertisements between age groups. Despite adolescents having an improved ability to recognize advertisement content and the persuasive intent of marketing compared to children, adolescents may be even more vulnerable to digital food marketing, because of their increased use of these platforms as well as desire to conform with social norms in their peer group (58, 59). Greater exposure to digital and social media platforms may also increase the number of subtle marketing strategies, for example viral marketing (peer-to-peer), contests, quizzes and marketing by influencers, which may not be captured in self-report measures if the participant is unable to identify these as marketing strategies.

4.1 Strengths and limitations

This study has a large sample size, and the same measures were used across countries, allowing justifiable comparisons between countries. Many studies use gross rating points or expenditure data as a proxy for exposure to advertising. While the latter provide objective data, they are unlikely to be accurate for digital advertising (46), and do not indicate who is exposed at the individual level, including individual-level correlates. More intensive approaches—such as devices that directly monitor websites or device usage—provide precise measures of exposure to marketing but are typically less feasible at a population level. One of the major strengths of this study is the wide range of social media platforms, and the differentiated locations of exposure to screen-based advertising assessed. Self-reported exposure to food marketing is a method used by researchers in large population samples (58, 60, 61) as a subjective indicator of actual exposure, although actual exposure is likely to be higher because of the frequent and implicit nature of marketing, resulting in a probable underestimation of exposure to marketing. Our measures may further underestimate exposure as such a measure may be less reliable in a sample of adolescents due to risk of recall errors, and inability to recognize all forms of marketing (particularly in digital media) (15).

This study is subject to limitations common to survey research. Respondents were recruited using non-probability based sampling; therefore, although the data were weighted by age group, sex, region, and ethnicity (except in Canada), the findings do not provide nationally representative estimates. In addition, there were notably higher levels of missing data for BMI in the UK. The measures used also have some limitations. For example, time spent watching cable television vs. on streaming applications (Netflix,

Crave, Amazon Prime Video, etc.) was not distinguished in this study. The amount of marketing exposure on cable television and free streaming websites compared to subscription platforms (that are typically ad-free) is likely very different, and this may play an important role in understanding the amount of exposure. Additionally, adolescents retrospectively self-reported the estimated screen time spent on each media channel rather than using a more objective approach, and this may have been influenced by whether or not a parent was present when completing the survey. This approach has not yet been validated in the literature, but nevertheless seems comparable to self-report estimates from other surveys. Responses may not be precisely accurate, and likely overestimate the absolute amount of screen time reported by youth as overall exposure was calculated by summing self-reported exposure to individual media channels and thus may include simultaneous use of multiple screens. Indicators of simultaneous viewing of screens were not directly measured in the survey. Nevertheless, this tool allows for comparisons of the relative amount of exposure across countries, as it is likely that the challenge of estimations, and associated error, would be similar across countries. Lastly, the measures did not distinguish between recreational screen time and screen time that was spent for school purposes (e.g., on websites).

4.2 Policy implications

These results reinforce the need to implement restrictive policies on marketing of unhealthy food and beverages appealing to a young audience, not only on television but also on digital media considering the widespread self-reported usage of social media platforms among adolescents across countries and the persuasiveness of marketing that is often targeted. Future research examining children's and adolescents' exposure to digital

marketing, as well as research modelling of the impact of potential policy measures, are likely to be important in making the case for restricting less healthy food and beverage content via these channels (62). This study also demonstrated the variety of media channels that are being used by adolescents, even though their content may not be 'child-targeted'(63) (i.e., social media, websites, etc.) but are indeed 'child appealing'(62, 64). Almost all social media platforms (such as Instagram, Facebook and Snapchat) have a minimum age of 13 to register (65-67), but previous research has suggested that nearly a quarter of children aged 8 to 11 years have an account (68), demonstrating that self-imposed age-restrictions are not effective. Our results were similar, with the younger adolescents (10-13 years) self-reporting widespread usage of social media platforms. The high rates of social media usage and self-reported exposure to advertisements via this medium further demonstrates the need for restrictions to limit exposure to this vulnerable age group.

The results of this study will be useful for future research as a baseline for comparison with exposure to less healthy food marketing after the implementation of marketing policies, but also in comparing adolescents' exposure to screen-based media and marketing after important worldwide events leading to possible changes in media consumption habits, such as changes in exposure as a result of the COVID-19 pandemic (69).

Ethics statement

The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 41477) and Laval University Ethics Committee (#2021-318). All participants provided informed consent to take part.

Contributorship statement

LV, CMW and DH designed research; CMW conducted research; EDP analyzed data and wrote the paper; LV had primary responsibility for final content; MW, MPK, DH, CN, CMW, XZ and LV reviewed and edited the manuscript. All authors read and approved the final manuscript.

Competing interests

None declared.

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Data availability statement

Data are available upon reasonable request. Data are available directly from the International Food Policy Study team on reasonable request (see www.foodpolicystudy.com).

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TABLES

Table 1. Sample characteristics of adolescents in six countries (weighted) N = 9171.

Characteristic	All countries (n=9171)	Australia (n=1127)	Canada (n=2869)	Chile (n=1124)	Mexico (n=1507)	UK (n=1140)	USA (n=1406)
				% (n)			
Age (years)							
10-13	50 (4551)	51 (574)	50 (1438)	47 (534)	50 (7[illegible])	49 (562)	49 (693)
14-17	50 (4620)	49 (553)	50 (1431)	53 (590)	50 (7[illegible])	51 (578)	51 (713)
Sex							
Male	51 (4664)	52 (582)	50 (1446)	51 (572)	51 (7[illegible])	51 (581)	51 (722)
Female	49 (4507)	48 (545)	50 (1423)	49 (552)	49 (7[illegible])	49 (559)	49 (684)
Ethnicity							
Majority group	76 (6976)	75 (850)	73 (2098)	85 (958)	78 (1170)	83 (941)	68 (959)
Minority group	24 (2195)	25 (277)	27 (771)	15 (166)	22 (335)	17 (199)	32 (447)
School grades							
Low	16 (1461)	32 (365)	13 (373)	6 (65)	7 (101)	29 (334)	16 (223)
Mid	38 (3508)	38 (430)	34 (974)	49 (555)	36 (549)	38 (430)	41 (570)
High	46 (4202)	29 (332)	53 (1522)	45 (505)	57 (855)	33 (375)	44 (613)
Perceived Income Adequacy							
Inadequate	24 (2222)	25 (283)	17 (488)	31 (345)	28 (418)	26 (291)	28 (397)
Adequate	76 (6949)	75 (844)	83 (2381)	69 (779)	72 (1089)	74 (849)	72 (1009)
Self-reported BMI							
Severe thinness/thinness/normal weight	49 (4480)	45 (509)	57 (1630)	43 (478)	48 (717)	41 (462)	49 (683)
Overweight	18 (1665)	16 (176)	16 (473)	21 (231)	22 (334)	13 (147)	22 (304)
Obesity	10 (927)	10 (113)	9 (255)	9 (97)	10 (148)	8 (92)	16 (222)
Not reported	23 (2100)	29 (328)	18 (511)	28 (319)	20 (306)	39 (439)	14 (197)

Table 2. Estimates from a linear regression model examining the amount of self-reported exposure to screen-based media (in minutes) on a weekday among adolescents in six countries (n=9171).

Parameter	Weekday screen time	
	Wald χ^2	B (CI)
Country	64.2	
AUS vs. CAN		-18.1 (-47.2,11.0)
AUS vs. CHILE		-170.2 (-205.8,-134.5)
AUS vs. MEX		-144.3 (-179.3,-109.3)
AUS vs. UK		-26.8 (-60.7,7.2)
AUS vs. USA		-107.8 (-142.6,-72.9)
CAN vs. CHILE		-152.1 (-181.9,-122.3)
CAN vs. MEX		-126.2 (-154.9,-97.5)
CAN vs. UK		-8.7 (-37.7,20.3)
CAN vs. USA		-89.7 (-118.2,-61.1)
CHILE vs. MEX		25.8 (-9.1,60.8)
CHILE vs. UK		143.4 (107.9,178.9)
CHILE vs. USA		62.4 (26.7,98.0)
MEX vs. UK		117.6 (82.7,152.4)
MEX vs. USA		36.5 (1.9,71.2)
UK vs. USA		-81.0 (-116.1,-45.9)
Sex	25.3	
Female vs. male		-34.7 (-52.4,-16.9)
Age	209.4	
10-13 years vs. 14-17 years		-99.7 (-117.4,-81.9)
Ethnicity	18.5	
Majority vs. minority		-38.9 (-62.2,-15.6)
Perceived income adequacy	16.0	
Adequate vs. inadequate		-33.0 (-54.3,-11.8)
School grades	19.9	
High vs. low		-64.0 (-90.7,-37.2)
High vs. mid		-26.6 (-46.2,-7.0)
Low vs. mid		37.4 (10.6,64.1)
BMI	16.9	
Not reported vs. Obesity		-67.5 (-102.2,-32.8)
Not reported vs. Overweight		-28.8 (-57.2,-0.3)
Not reported vs. Severe thinness/thinness/normal weight		12.4 (-10.3,35.1)
Obesity vs. Overweight		38.7 (2.5,74.9)
Obesity vs. Severe thinness/thinness/normal weight		79.9 (47.8,112.0)
Overweight vs. Severe thinness/thinness/normal weight		41.2 (16.4,65.9)

* : Indicates significant Wald χ^2 test.

Notes: The variable listed second is the reference variable.

Abbreviations: AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; B=Beta; CI = 99% confidence interval.

Table 3. Estimates from separate logistic regression models examining self-reported exposure to social media platforms among adolescents in six countries (n=9171).

Parameter	Exposure to Facebook		Exposure to Instagram		Exposure to TikTok		Exposure to Twitter		Exposure to Snapchat		No exposure to social media	
	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)
Country	81.7		17.6		15.2		28.4		13.3		10.0	
AUS vs. CAN		1.28 (1.04,1.56)		0.90 (0.73,1.11)		0.80 (0.64,1.00)		0.92 (0.70,1.20)		0.77 (0.63,0.95)		1.29 (1.01,1.66)
AUS vs. CHILE		0.81 (0.63,1.04)		0.48 (0.37,0.62)		1.41 (1.07,1.86)		0.72 (0.52,0.99)		1.96 (1.50,2.56)		1.72 (1.25,2.36)
AUS vs. MEX		0.23 (0.18,0.30)		0.95 (0.74,1.21)		1.54 (1.15,2.04)		0.37 (0.28,0.50)		1.57 (1.22,2.03)		2.18 (1.57,3.03)
AUS vs. UK		0.89 (0.70,1.14)		0.82 (0.64,1.05)		1.05 (0.80,1.36)		0.54 (0.40,0.73)		0.62 (0.48,0.79)		1.59 (1.16,2.18)
AUS vs. USA		0.84 (0.66,1.06)		1.06 (0.83,1.35)		0.85 (0.66,1.09)		0.60 (0.44,0.81)		0.73 (0.57,0.92)		1.19 (0.89,1.60)
CAN vs. CHILE		0.64 (0.51,0.79)		0.53 (0.43,0.66)		1.76 (1.40,2.22)		0.78 (0.61,1.01)		2.53 (2.02,3.18)		1.33 (1.01,1.75)
CAN vs. MEX		0.18 (0.14,0.22)		1.05 (0.86,1.28)		1.92 (1.51,2.44)		0.41 (0.33,0.51)		2.03 (1.64,2.50)		1.69 (1.27,2.25)
CAN vs. UK		0.70 (0.56,0.87)		0.91 (0.73,1.12)		1.31 (1.04,1.64)		0.59 (0.46,0.76)		0.80 (0.65,0.98)		1.23 (0.93,1.63)
CAN vs. USA		0.66 (0.54,0.80)		1.17 (0.96,1.42)		1.06 (0.87,1.30)		0.65 (0.52,0.82)		0.94 (0.78,1.13)		0.92 (0.72,1.18)
CHILE vs. MEX		0.28 (0.22,0.37)		1.96 (1.54,2.51)		1.09 (0.82,1.46)		0.52 (0.40,0.68)		0.80 (0.61,1.05)		1.27 (0.91,1.78)
CHILE vs. UK		1.10 (0.85,1.42)		1.70 (1.32,2.19)		0.74 (0.56,0.98)		0.75 (0.56,1.01)		0.31 (0.24,0.41)		0.92 (0.66,1.30)
CHILE vs. USA		1.04 (0.81,1.32)		2.19 (1.71,2.80)		0.60 (0.46,0.79)		0.83 (0.63,1.10)		0.37 (0.29,0.48)		0.69 (0.51,0.95)
MEX vs. UK		3.91 (2.99,5.10)		0.86 (0.67,1.11)		0.68 (0.51,0.91)		1.46 (1.11,1.90)		0.39 (0.30,0.51)		0.73 (0.51,1.03)
MEX vs. USA		3.68 (2.86,4.73)		1.11 (0.88,1.42)		0.55 (0.42,0.73)		1.61 (1.25,2.07)		0.46 (0.36,0.59)		0.55 (0.40,0.75)
UK vs. USA		0.94 (0.74,1.20)		1.29 (1.01,1.66)		0.81 (0.63,1.05)		1.11 (0.83,1.46)		1.18 (0.93,1.50)		0.75 (0.54,1.04)
Sex	0.6		69.7		250.4		1.9		86.6		85.3	
Female vs. male		1.04 (0.92,1.18)		1.50 (1.33,1.71)		2.31 (2.02,2.65)		0.92 (0.80,1.07)		1.87 (1.65,2.12)		0.55 (0.47,0.65)
Age	601.2		705.2		30.1		380.7		406.4		588.0	
10-13 years vs. 14-17 years		0.30 (0.26,0.34)		0.27 (0.24,0.30)		1.34 (1.17,1.54)		0.31 (0.27,0.36)		0.37 (0.32,0.42)		6.24 (5.14,7.58)
Ethnicity	0.4		1.5		0.0		2.3		2		1.1	
Majority vs. minority		0.96 (0.82,1.13)		0.93 (0.79,1.09)		1.01 (0.85,1.20)		0.90 (0.74,1.08)		0.97 (0.83,1.14)		1.09 (0.88,1.34)
Perceived income adequacy	6.1		2.6		1.3		7.6		4		0.1	
Adequate vs. inadequate		0.87 (0.75,1.01)		1.10 (0.95,1.27)		0.93 (0.80,1.09)		1.20 (1.01,1.43)		0.96 (0.83,1.12)		1.02 (0.84,1.23)
School grades	11.1		2.3		10.2		2.1		13*		12.3	
High vs. low		0.80 (0.66,0.97)		0.98 (0.81,1.18)		0.73 (0.60,0.89)		1.20 (0.95,1.51)		0.83 (0.69,1.00)		1.42 (1.11,1.82)
High vs. mid		0.78 (0.68,0.90)		0.89 (0.78,1.03)		0.82 (0.71,0.96)		1.03 (0.88,1.21)		0.82 (0.72,0.95)		1.35 (1.13,1.61)
Low vs. mid		0.98 (0.81,1.18)		0.92 (0.76,1.11)		1.13 (0.93,1.38)		0.86 (0.68,1.08)		0.99 (0.82,1.19)		0.95 (0.74,1.22)
BMI	12.1		7.8		3.0		4.1		0.8		12.8	
Not reported vs. Obesity		0.64 (0.50,0.81)		0.74 (0.58,0.94)		0.78 (0.61,1.00)		0.77 (0.58,1.02)		0.71 (0.56,0.90)		1.86 (1.38,2.52)
Not reported vs. Overweight		0.72 (0.59,0.89)		0.74 (0.61,0.90)		0.85 (0.69,1.05)		0.78 (0.61,0.98)		0.69 (0.56,0.84)		1.59 (1.24,2.04)
Not reported vs. Severe thinness/thinness/normal weight		0.93 (0.79,1.10)		0.76 (0.65,0.90)		0.95 (0.80,1.13)		0.94 (0.77,1.15)		0.72 (0.61,0.85)		1.32 (1.09,1.62)
Obesity vs. Overweight		1.13 (0.88,1.45)		1.00 (0.78,1.28)		1.09 (0.84,1.41)		1.02 (0.77,1.35)		0.97 (0.76,1.24)		0.85 (0.62,1.18)
Obesity vs. Severe thinness/thinness/normal weight		1.46 (1.17,1.82)		1.03 (0.83,1.29)		1.22 (0.97,1.53)		1.23 (0.96,1.59)		1.02 (0.82,1.26)		0.71 (0.53,0.95)
Overweight vs. Severe thinness/thinness/normal weight		1.28 (1.08,1.53)		1.03 (0.87,1.23)		1.12 (0.93,1.34)		1.21 (1.00,1.48)		1.05 (0.88,1.24)		0.83 (0.66,1.05)

Notes : The variable listed second is the reference variable.
Abbreviations : AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; CI = 99% confidence interval.

Table 4. Estimates from separate logistic regression models examining daily self-reported exposure to sugary beverage and fast food advertisements among adolescents in six countries on a weekday (n=9171).

Parameter	Daily exposure to sugary drinks ads		Daily exposure to fast food ads	
	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)
Country	70.4*		24.3*	
AUS vs. CAN		0.89 (0.69,1.15)		0.89 (0.72,1.10)
AUS vs. CHILE		0.37 (0.28,0.49)		1.11 (0.86,1.43)
AUS vs. MEX		0.29 (0.22,0.38)		0.90 (0.70,1.15)
AUS vs. UK		1.77 (1.26,2.50)		2.00 (1.52,2.62)
AUS vs. USA		0.62 (0.47,0.81)		0.67 (0.52,0.84)
CAN vs. CHILE		0.41 (0.33,0.52)		1.24 (1.00,1.54)
CAN vs. MEX		0.33 (0.27,0.41)		1.00 (0.82,1.23)
CAN vs. UK		1.99 (1.47,2,70)		2.24 (1.76,2.84)
CAN vs. USA		0.69 (0.56,0.86)		0.75 (0.62,0.90)
CHILE vs. MEX		0.79 (0.62,1.00)		0.81 (0.63,1.03)
CHILE vs. UK		4.80 (3.46,6.67)		1.80 (1.36,2.39)
CHILE vs. USA		1.67 (1.30,2.14)		0.60 (0.47,0.76)
MEX vs. UK		6.07 (4.39,8.39)		2.23 (1.69,2.94)
MEX vs. USA		2.11 (1.66,2.68)		0.74 (0.59,0.94)
UK vs. USA		0.35 (0.25,0.48)		0.33 (0.26,0.43)
Sex	1.5		0.4	
Female vs. male		1.07 (0.93,1.23)		1.03 (0.91,1.17)
Age	0.0		1.2	
10-13 years vs. 14-17 years		1.00 (0.86,1.16)		0.95 (0.83,1.08)
Ethnicity	0.1		0.0	
Majority vs. minority		1.02 (0.85,1.23)		1.00 (0.85,1.18)
Perceived income adequacy	1.0		4.5	
Adequate vs. inadequate		0.94 (0.80,1.11)		0.88 (0.76,1.03)
School grades	0.4		3.2	
High vs. low		0.93 (0.75,1.17)		0.95 (0.79,1.15)
High vs. mid		0.96 (0.82,1.13)		0.87 (0.76,1.00)
Low vs. mid		1.03 (0.83,1.29)		0.92 (0.76,1.11)
BMI	6.3*		6.4*	
Not reported vs. Obesity		0.73 (0.56,0.95)		0.75 (0.59,0.94)
Not reported vs. Overweight		0.70 (0.56,0.88)		0.75 (0.61,0.92)
Not reported vs. Severe thinness/thinness/normal weight		0.79 (0.66,0.96)		0.78 (0.66,0.93)
Obesity vs. Overweight		0.96 (0.74,1.25)		1.01 (0.79,1.28)
Obesity vs. Severe thinness/thinness/normal weight		1.09 (0.86,1.38)		1.05 (0.85,1.30)
Overweight vs. Severe thinness/thinness/normal weight		1.14 (0.94,1.38)		1.04 (0.88,1.24)
Exposure to screen based media (weekday)	88.2*	1.05 (1.04,1.07)	121.4*	1.05 (1.04,1.07)

* Indicates significant Wald χ^2 test.

Note : The variable listed second is the reference variable. Exposure to screen based media is expressed in minutes.

Abbreviations: AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; CI = 99% confidence interval.

FIGURES

Figure 1. Mean hours of total self-reported screen time (including YouTube, social media, television, playing games and browsing) on a weekday among adolescents in six countries after winsorization (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

Figure 2. Percentage of adolescents in six countries self-reporting using platforms of social media (Facebook; Instagram; TikTok; Twitter; Snapchat; None) (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

Figure 3. Percentage of adolescents in six countries self-reporting exposure to advertisements for unhealthy foods or drinks in three locations (TV shows, series or movies; Website or social media ; Video or computer games; None) in the last 30 days (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

Figure 4. Percentage of adolescents in six countries self-reporting daily exposure to advertisements for sugary drinks and fast food in the last 30 days (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

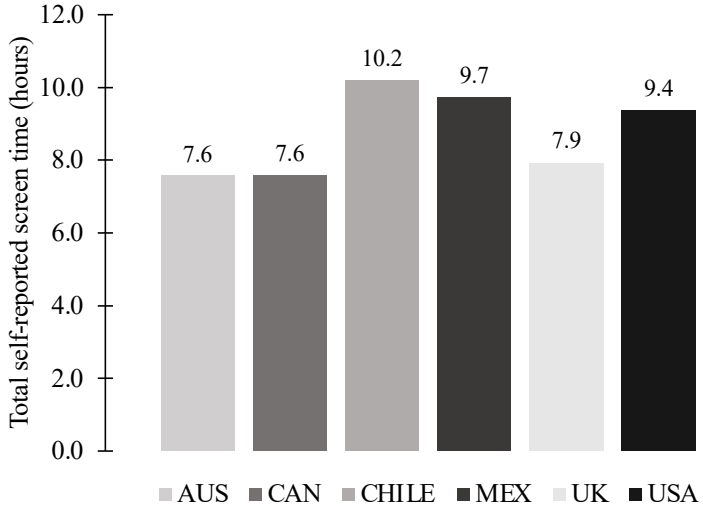

Figure 1. Mean hours of total self-reported screen time (including YouTube, social media, television, playing games and browsing) on a weekday among adolescents in six countries after winsorization (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

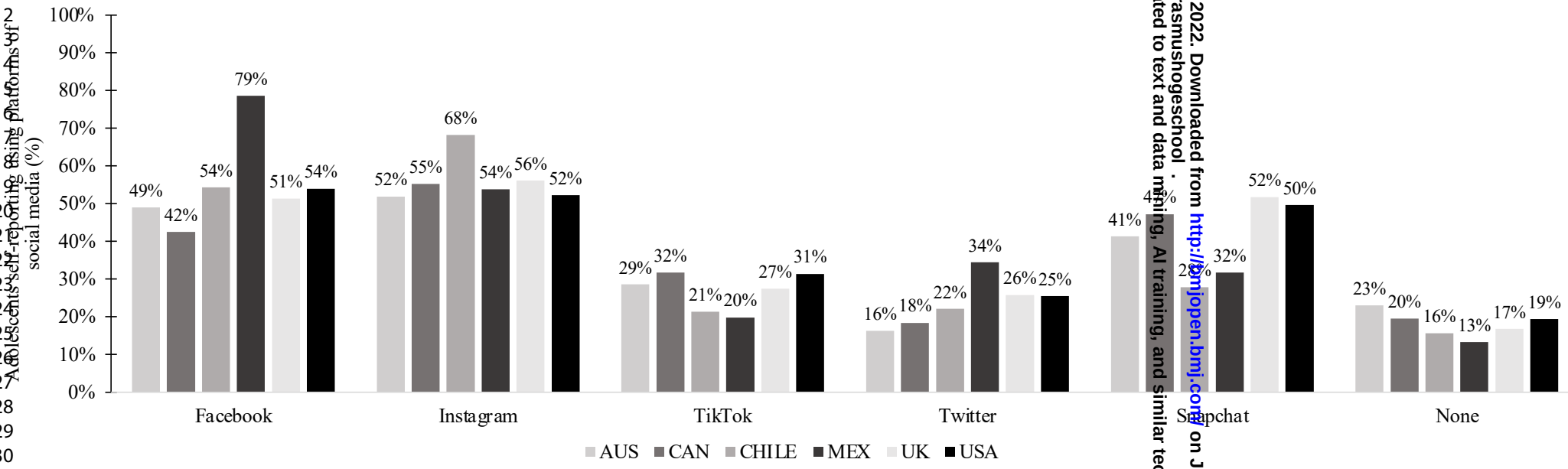

Figure 2. Percentage of adolescents in six countries self-reporting using platforms of social media (Facebook; Instagram; TikTok; Twitter; Snapchat; None) (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

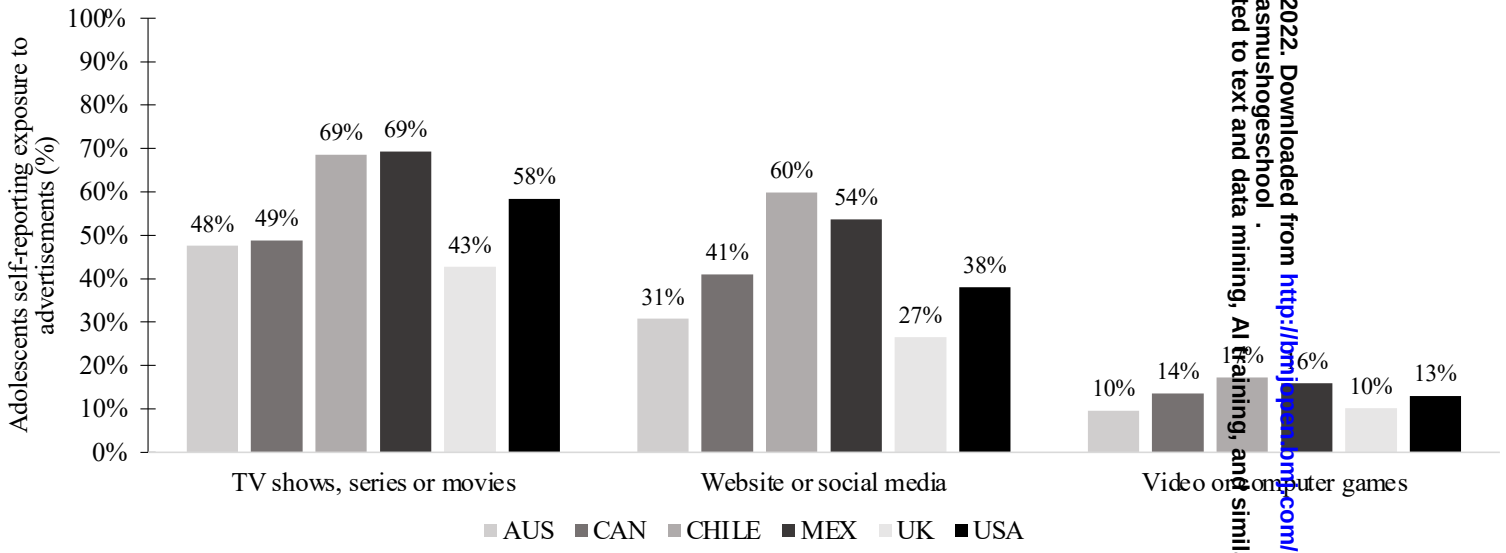

Figure 3. Percentage of adolescents in six countries self-reporting exposure to advertisements for unhealthy foods or drinks in three locations (TV shows, series or movies; Website or social media ; Video or computer games; None) in the last 30 days (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

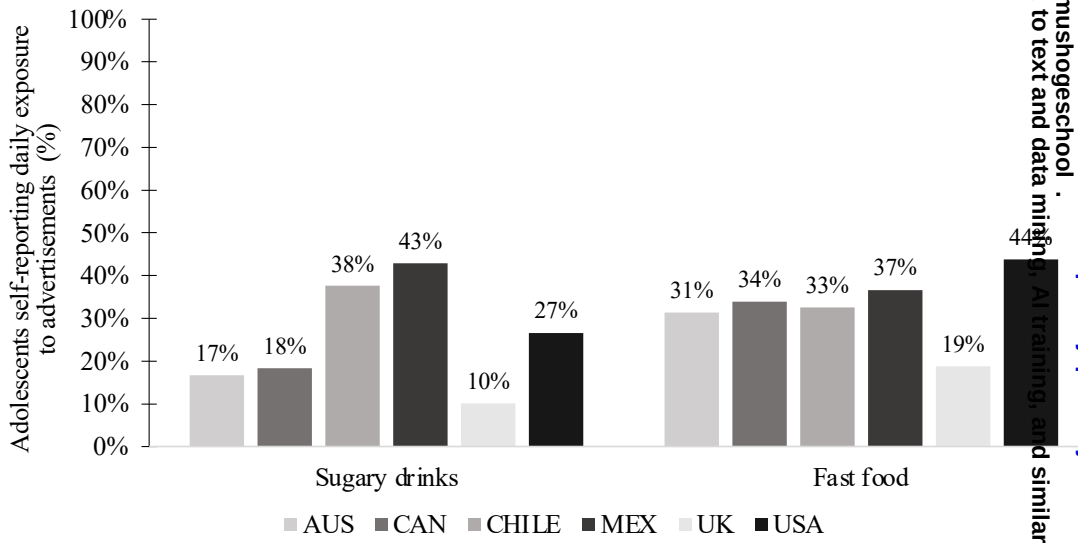

Figure 4. Percentage of adolescents in six countries self-reporting daily exposure to advertisements for sugary drinks and fast food in the last 30 days (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

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Supplementary Table S1. Estimates from separate linear regression models examining the amount of self-reported exposure to screen-based media (in minutes) on a weekend day among adolescents in six countries (n=9171).

Parameter	Weekend day screen time	
	Wald χ^2	B (CI)
Country	47.0*	
AUS vs. CAN		-6.8 (-35.7,22.0)
AUS vs. CHILE		-136.9 (-173.8,-100.0)
AUS vs. MEX		-130.0 (-165.4,-94.7)
AUS vs. UK		-26.7 (-60.8,7.4)
AUS vs. USA		-85.6 (-120.1,-51.1)
CAN vs. CHILE		-130.1 (-161.3,-98.8)
CAN vs. MEX		-123.2 (-152.1, -94.2)
CAN vs. UK		-19.8 (-48.7,9.0)
CAN vs. USA		-78.8 (-107.0,-50.6)
CHILE vs. MEX		6.9 (-29.7,43.5)
CHILE vs. UK		110.2 (73.4,147.1)
CHILE vs. USA		51.3 (14.5,88.1)
MEX vs. UK		103.3 (68.2,138.5)
MEX vs. USA		44.4 (9.6,79.2)
UK vs. USA		-58.9 (-93.8,-24.1)
Sex	15.0*	
Female vs. male		-27.0 (-44.9,-9.0)
Age	167.5*	
10-13 years vs. 14-17 years		-90.3 (-108.3,-72.4)
Ethnicity	13.0*	
Majority vs. minority		-32.9 (-56.3,-9.4)
Perceived income adequacy	32.0*	
Adequate vs. inadequate		-47.2 (-68.8,-25.7)
School grades	30.7*	
High vs. low		-79.7 (-106.7,-52.6)
High vs. mid		-35.8 (-55.6,-16.1)
Low vs. mid		43.8 (16.9,70.7)
BMI	10.7*	
Not reported vs. Obesity		-66.2 (-100.0,-32.4)
Not reported vs. Overweight		-20.6 (-48.6,7.4)
Not reported vs. Severe thinness/thinness/normal weight		-2.0 (-25.2,21.1)
Obesity vs. Overweight		45.6 (10.8,80.4)
Obesity vs. Severe thinness/thinness/normal weight		64.2 (32.9,95.5)
Overweight vs. Severe thinness/thinness/normal weight		18.6 (-5.9,43.0)

* : Indicates significant Wald χ^2 test.

Notes : The variable listed second is the reference variable.

Abbreviations : AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; B=Beta; CI = 99% confidence interval.

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Supplementary Table S2. Estimates from separate logistic regression models examining daily self-reported exposure to sugary beverage and fast food advertisements among adolescents in six countries on a weekend day (n=9171).

Parameter	Daily exposure to sugary drinks ads		Daily exposure to fast food ads	
	Wald χ^2	Odds ratio (CI)	Wald χ^2	Odds ratio (CI)
Country	70.2*		24.8*	
AUS vs. CAN		0.88 (0.69,1.13)		0.88 (0.72,1.09)
AUS vs. CHILE		0.37 (0.28,0.49)		1.11 (0.86,1.44)
AUS vs. MEX		0.29 (0.22,0.39)		0.91 (0.71,1.17)
AUS vs. UK		1.78 (1.26,2.52)		2.02 (1.54,2.65)
AUS vs. USA		0.61 (0.47,0.81)		0.66 (0.52,0.84)
CAN vs. CHILE		0.42 (0.33,0.52)		1.26 (1.01,1.57)
CAN vs. MEX		0.33 (0.27,0.41)		1.03 (0.84,1.27)
CAN vs. UK		2.02 (1.49,2.75)		2.29 (1.80,2.90)
CAN vs. USA		0.70 (0.56,0.86)		0.75 (0.62,0.91)
CHILE vs. MEX		0.80 (0.63,1.02)		0.82 (0.64,1.05)
CHILE vs. UK		4.86 (3.50,6.76)		1.81 (1.37,2.40)
CHILE vs. USA		1.67 (1.30,2.15)		0.59 (0.47,0.76)
MEX vs. UK		6.08 (4.40,8.40)		2.22 (1.68,2.92)
MEX vs. USA		2.09 (1.64,2.66)		0.73 (0.58,0.92)
UK vs. USA		0.34 (0.25,0.48)		0.33 (0.25,0.43)
Sex	1.3		0.3	
Female vs. male		1.07 (0.92,1.23)		1.03 (0.91,1.17)
Age	0.0		0.7	
10-13 years vs. 14-17 years		1.01 (0.87,1.17)		0.96 (0.84,1.09)
Ethnicity	0.0		0.0	
Majority vs. minority		1.02 (0.85,1.23)		1.00 (0.85,1.18)
Perceived income adequacy	0.5		3.1	
Adequate vs. inadequate		0.95 (0.81,1.13)		0.90 (0.78,1.05)
School grades	0.1		2.7	
High vs. low		0.96 (0.77,1.20)		0.98 (0.81,1.19)
High vs. mid		0.98 (0.84,1.15)		0.89 (0.77,1.02)
Low vs. mid		1.02 (0.81,1.27)		0.90 (0.74,1.09)
BMI	6.3*		6.0*	
Not reported vs. Obesity		0.74 (0.57,0.96)		0.76 (0.60,0.96)
Not reported vs. Overweight		0.70 (0.56,0.87)		0.75 (0.61,0.92)
Not reported vs. Severe thinness/thinness/normal weight		0.81 (0.66,0.98)		0.79 (0.67,0.94)
Obesity vs. Overweight		0.94 (0.72,1.23)		0.99 (0.78,1.26)
Obesity vs. Severe thinness/thinness/normal weight		1.09 (0.86,1.38)		1.05 (0.85,1.30)
Overweight vs. Severe thinness/thinness/normal weight		1.16 (0.96,1.40)		1.06 (0.89,1.27)
Exposure to screen based media (weekend day)	128.7*	1.06 (1.05,1.08)	186.5*	1.07 (1.06,1.08)

* : Indicates significant Wald χ^2 test.

Notes : The variable listed second is the reference variable. Exposure to screen based media is expressed in minutes.
Abbreviations : AUS=Australia, CAN=Canada, MEX=Mexico, UK=United Kingdom, USA=United States of America; CI = 99% confidence interval.

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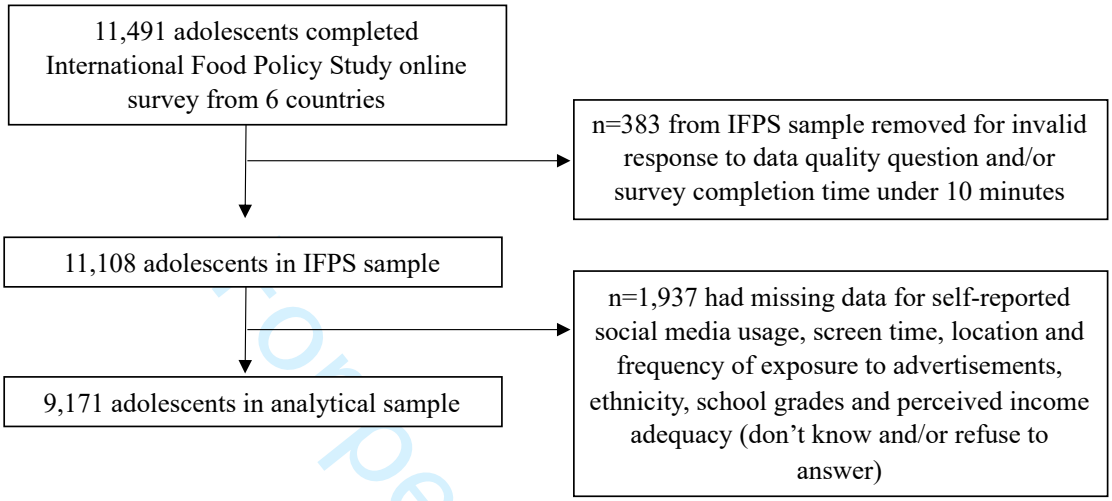

Supplementary Figure S1. Flow chart of participants included in the analytical sample.

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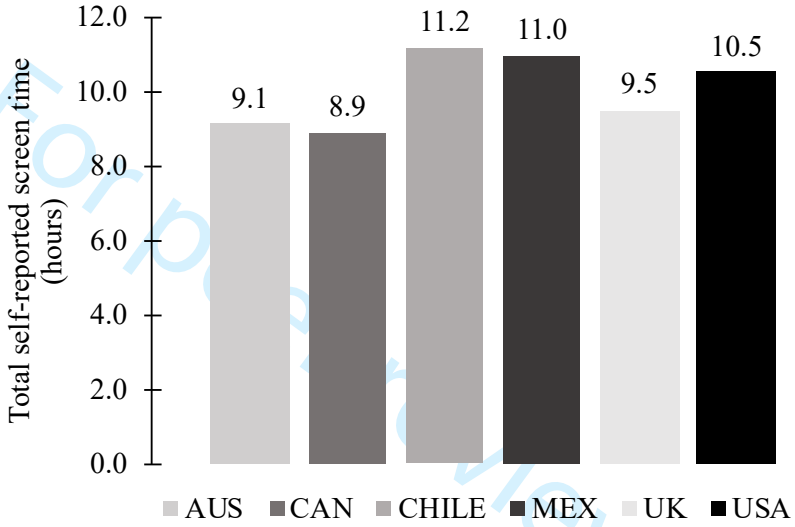
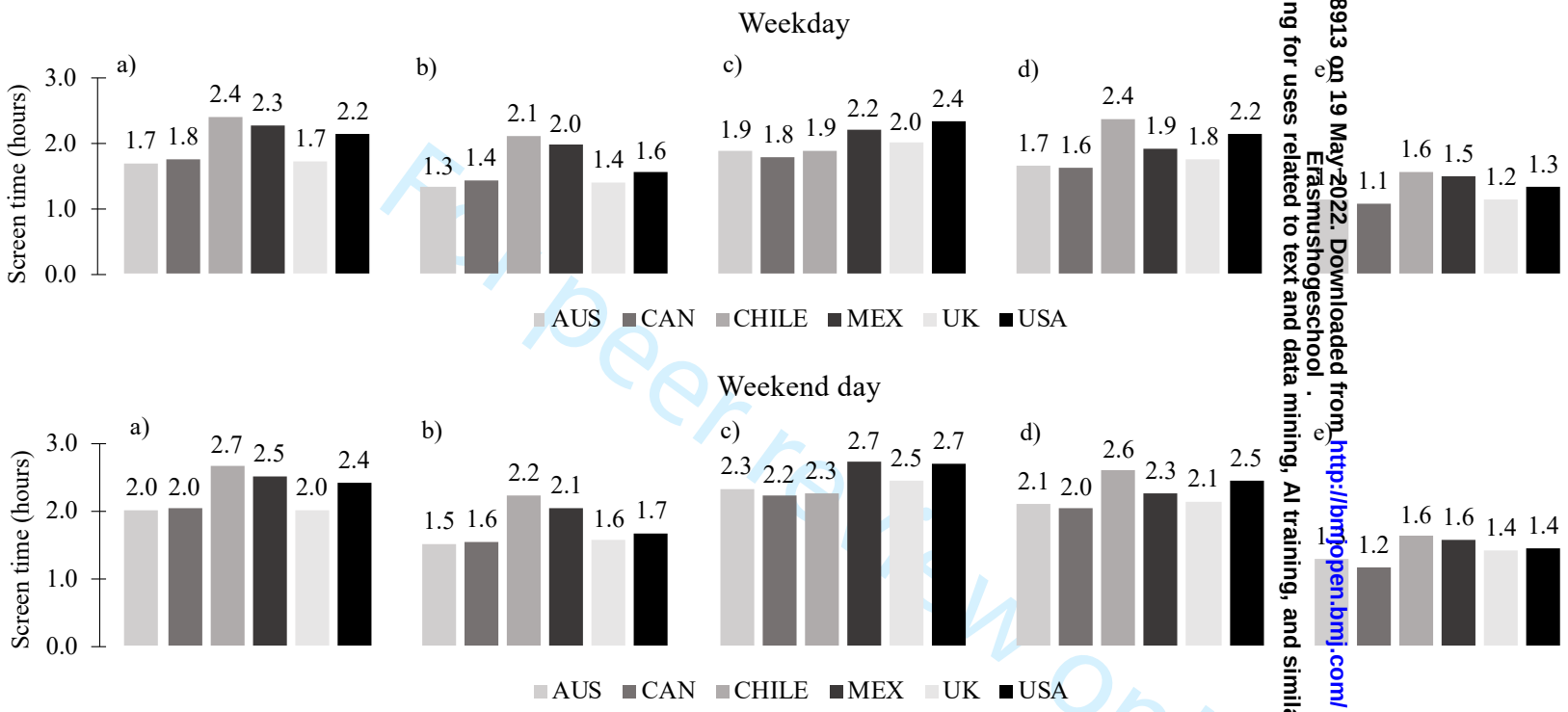


Supplementary Figure S2. Mean hours of total self-reported screen time (including YouTube, social media, television, playing games and browsing) on a weekend day among adolescents in six countries after winsorization (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

SUPPLEMENTARY MATERIAL – DEMERS-POTVIN ET AL.

Adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing

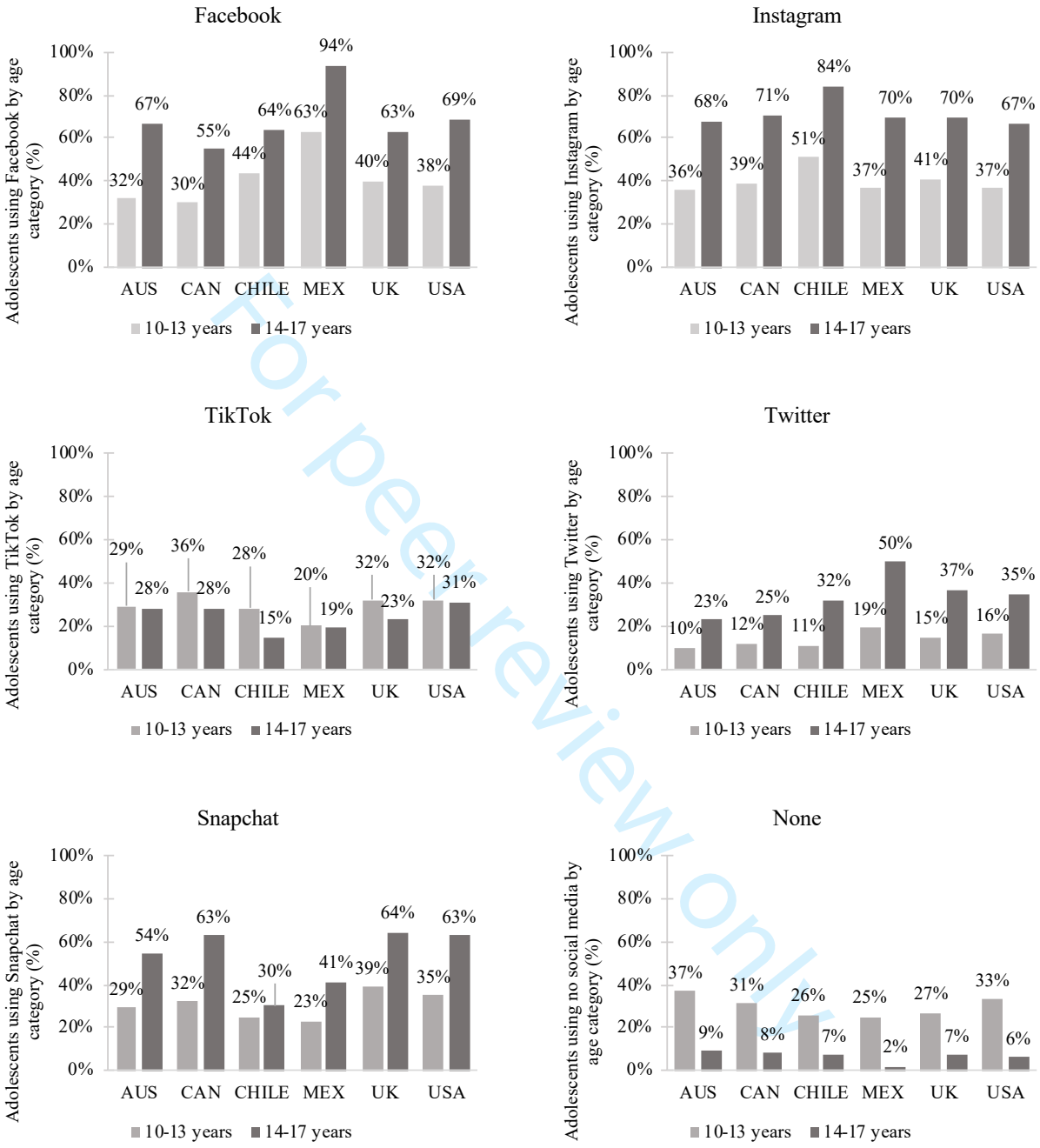


Supplementary Figure S3. Mean amount of self-reported screen time (in hours) for five media channels on a weekday (above) and weekend day (below) among adolescents in six countries before winsorization (n=9171).
a) Watching YouTube
b) On social media (including messaging, posting, or liking posts)
c) Watching TV shows, series, or movies
d) Playing games on smartphones, computers, or game consoles
e) Browsing, reading websites, Googling, etc.

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

SUPPLEMENTARY MATERIAL – DEMERS-POTVIN ET AL.

Adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing

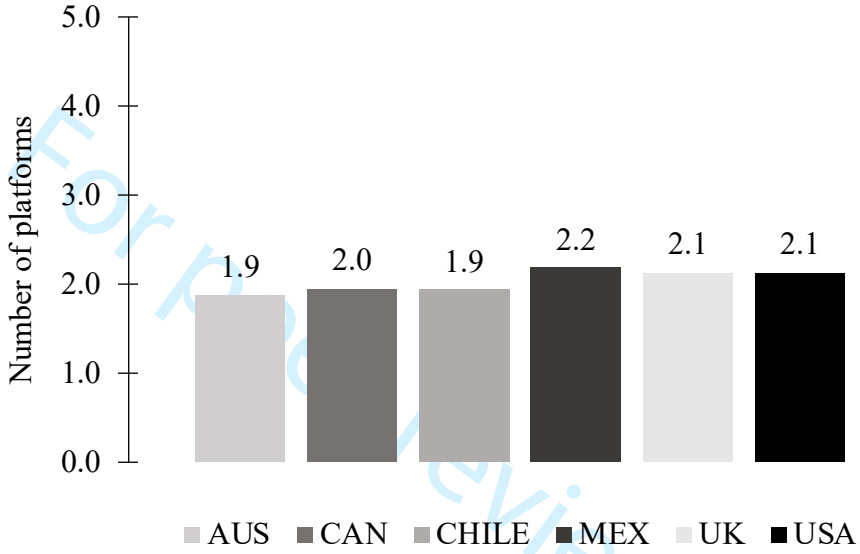


Supplementary Figure S4. Percentage of adolescents in six countries self-reporting using platforms of social media (Facebook; Instagram; TikTok; Twitter; Snapchat; None) by age category (n=9171).

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

SUPPLEMENTARY MATERIAL – DEMERS-POTVIN ET AL.

Adolescents' media usage and self-reported exposure to advertising across six countries: implications for less healthy food and beverage marketing



Supplementary Figure S5. Mean number of social media platforms self-reported being used among adolescents in six countries (n=9171) [a].

Abbreviations : AUS = Australia, CAN = Canada, MEX = Mexico, UK = United Kingdom, USA = United States of America.

[a] Range of 0 to 5 possible social media platforms.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	11
Study size	10	Explain how the study size was arrived at	12
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-13
		(*b*) Describe any methods used to examine subgroups and interactions	13
		(*c*) Explain how missing data were addressed	12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	13
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	12
		(c) Consider use of a flow diagram	12
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	12, SFig 1
Outcome data	15*	Report numbers of outcome events or summary measures	14-16
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 3

		(*b*) Report category boundaries when continuous variables were categorized	13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	23-24
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-22
Generalisability	21	Discuss the generalisability (external validity) of the study results	24-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.