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BRIEF COMMUNICATION

Parents’ considerable underestimation of sugar and their child’s risk of overweight

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Abstract

High sugar intake is associated with an increased risk of overweight. For parents, as their children’s nutritional gatekeepers, knowledge about sugar is a prerequisite for regulating sugar consumption. Yet little is known about parental ability to estimate the sugar content of foods and beverages and how this ability is associated with children’s body mass index (BMI). In 305 parent–child pairs, we investigated to what extent parents systematically under- or overestimate the sugar content of foods and beverages commonly found in children’s diets as well as potential associations with children’s z-BMI. Parents considerably underestimated the sugar content of most foods and beverages (e.g., 92% of parents underestimated the sugar content of yogurt by, on average, seven sugar cubes). After controlling for parental education and BMI, parental sugar underestimation was significantly associated with a higher risk of their child being overweight or obese (odds ratio = 2.01). There was a small dose–response relationship between the degree of underestimation and the child’s z-BMI. These findings suggest that providing easily accessible and practicable knowledge about sugar content through, for instance, nutritional labeling may improve parents’ intuition about sugar. This could help curtail sugar intake in children and thus be a preventive measure for overweight.

Introduction

Sugar intake is a potential contributor to overweight and obesity [1]. The World Health Organization (WHO) recommends reducing consumption of free sugars to less than 10% of total daily energy intake (~50 g or 16 sugar cubes for an average adult) [2]. Yet a large proportion of the population considerably exceeds this threshold [3]. High sugar consumption in children is of particular concern, because eating habits are established early in life [4]. Parents are their children’s nutritional gatekeepers and determine ~70% of what they eat [5]. Thus, one promising approach to reduce children’s sugar consumption is to boost parents’food-related decision competences [6].

Adequate nutrition knowledge is one building block for making healthy dietary decisions [7]. For example, providing caloric information on sugar-sweetened beverages has led to attitude changes [8] and reduced purchases [9]. Also, parental knowledge about sugar content in beverages has been associated with their child’s intake of dairy drinks [10]. More generally, intuitive knowledge about the sugar content of foods may shape to what extent they are perceived as health risks. Relatedly, interventions fostering health knowledge can increase risk perception [11], which, in turn, is one important predictor of health behavior [12].

What role does parents’ (intuitive) knowledge about sugar in foods and beverages play in their children’s sugar consumption? To our best knowledge, this is the first study to examine systematic under- and overestimation of sugar content in common foods and beverages and to explore potential consequences. The large amounts of added sugar in common foods can defy reasonable expectations, in particular when the foods in question are not explicitly designated to be treats. Therefore, we hypothesized that most parents underestimate the sugar content of common foods and beverages and that systematic underestimation of

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sugar is associated with a higher risk of their child being overweight.

Materials and methods

In 2015, a market research institute was commissioned to collect the data. A sample of the residents of Germany was created using a quota sampling method with quotas on gender, age, region, education, size of town, and household. Within the sample, only nutritional gatekeepers—that is, parents identifying themselves as responsible for planning and preparing the family's food—with at least one child aged between 6 and 12 years were included. A trained interviewer visited participants at home. Questionnaires on demographics (see Table S1 in Supplemental Materials) and the sugar estimation task were presented on a laptop. Body weight and height were measured. The standardized BMI (z-BMI) of each child was classified as obese, overweight, normal weight, or underweight using age- and gender-specific thresholds for BMI from a representative reference population [13]. Four parent–child pairs were excluded because of errors in data entry, resulting in biologically implausible z-BMI values in the children (z-BMI<-4) [14]. The final data set included 305 parent–child pairs; participants gave informed consent. The ethics committee of the Max Planck Institute for Human Development approved the study.

Sugar estimation task

The computer-based task was tested in a pilot study. First, parents were informed about the WHO recommendation to obtain not more than 10% of their total daily energy intake from sugar (equivalent to ~16 sugar cubes for an average adult). This provided all participants with the same base reference in the estimation task, allowing us to avoid idiosyncratic anchoring effects [15]. We also informed them that a sugar cube is equivalent to 3 g of sugar. Next, parents saw pictures of six foods and beverages and were asked to estimate the total amount of sugar (e.g., "How many sugar cubes in total do you think are in this granola bar?"). The estimation scale using sugar cubes as the unit of measure was developed with a nutritionist and a physician. The included items were chosen to represent various components of most people's daily sugar intake (i.e., beverages, snacks, and meal constituents; items commonly perceived as sugary and less healthy and items mostly perceived as less sugary and more healthy). All items represented frequently consumed foods and beverages in a usual serving size. Reliability was acceptable (Cronbach's alpha = 0.70). The items (orange juice, cola, pizza, fruit yogurt, granola bar, and ketchup) were presented in random order. To generate a robust summary score, items were weighted equally. We excluded one item (i.e., a jar of red cabbage) from further analyses, because a jar does not represent a single serving size. Importantly, all effects (odds ratios and correlation coefficients) were significant and larger when red cabbage was included. Parental estimations were scored using the deviation between estimated (e_i) and true (t_i) number of sugar cubes. Three scores were calculated: (a) a summary estimation score (ES), indicating the total deviation across all items (the score was dichotomized into underestimation [ES < 0] and overestimation [ES > 0]); the ES indicates whether, when taking all items together, sugar was more underestimated (ES < 0) or overestimated (ES > 0); (b) an underestimation score (US), aggregating across cases of underestimation (setting all other cases to 0); the US was inverted for easier interpretation, so that a higher score indicates a higher degree of underestimation; and (c) an overestimation score (OS), aggregating across cases of sugar overestimation (setting all other cases to 0). A higher OS score indicates a higher degree of overestimation.

$$\mathrm{ES} = \sum_{i=1}^{6} (e_i - t_i);$$

$$\mathrm{US} = \left(\sum_{i=1}^{6} \begin{cases} \text{if } (e_i - t_i) < 0, \\ 0 \text{ otherwise} \end{cases} \right) \times (-1);$$

$$\mathrm{OS} = \sum_{i=1}^{6} \begin{cases} \text{if } (e_i - t_i) > 0, \\ 0 \text{ otherwise} \end{cases}$$

Statistical analyses

The association between parental sugar underestimation and children's weight status was tested with a multinomial logistic regression analysis. Overweight and underweight served as dependent variables and normal weight as reference. Sugar underestimation (ES < 0) served as independent variable with overestimation (ES > 0) as reference. Odds ratios (ORs) were adjusted for the potential confounding variables parental education and BMI. Relationships between children's z-BMI, ES, US, and OS were tested using correlation analyses. The association between US and z-BMI in children was examined with a regression analysis, adjusted for parental education and BMI. See Table S2 in Supplemental Materials for correlations between all included variables. All statistical analyses were performed using SPSS v.22.0 and using *rms* package for R.

Table 1 Descriptive statistics of parents' sugar estimation scores

Item	% of parents estimating sugar content			Mean (SD) under- and overestimation[a,b]		Estimate as % of total sugar content[a,b]	
	Under	Over	Correct	Under	Over	Under	Over
100% orange juice (one glass, 330ml)	84.6	8.5	6.8	−7.18 (2.20)	5.73 (3.22)	71	57
Cola (one glass, 330ml)	56.1	44.3	0	−4.74 (3.56)	5.39 (3.23)	41	47
Frozen pizza (one box, 350g)	67.9	32.1	0	−3.85 (1.93)	4.77 (4.22)	59	73
Fruit yogurt (one container, 250g)	92.1	7.6	0.3	−7.00 (2.74)	4.13 (2.82)	64	38
Chocolate granola bar (one bar, 25g)	29.8	66.2	4.0	−1.10 (0.82)	3.87 (3.56)	44	152
Ketchup (single serving packet, 20g)	25.6	46.9	27.5	−1.10 (0.52)	4.44 (4.40)	61	293

$N = 305$

[a]In number of sugar cubes

[b]Parents who correctly estimated the sugar content were not taken into account

Results

Performance on sugar estimation task

For each item the percentage of parents who underestimated, overestimated, or correctly estimated the sugar content and the mean under- and overestimation expressed as sugar cubes are summarized in Table 1.

Association between sugar estimation and children's BMI

A total of 224 parents (74%) had a negative summary score (ES < 0). This means that they overall underestimated the sugar content across all food and beverage items. Furthermore, the logistic regression analysis revealed that underestimation was a significant predictor of children's overweight (OR: 2.01; 95% confidence interval, CI (1.04–3.91), $P = 0.039$) but not of underweight (OR: 2.52; 95% CI (0.826–7.721), $P = 0.104$). Table 2 shows the correlations between the parental summary estimation score (ES), underestimation score (US), overestimation score (OS), and children's z-BMI. A regression analysis controlling for educational level and BMI of parents indicated a significant dose–response relationship between the degree of underestimation and children's z-BMI ($\beta = -0.110$; $P = 0.026$).

Table 2 Correlations between parental summary estimation score (ES), underestimation score (US), overestimation score (OS), and children's z-BMI

	ES	US	OS
ES	–		
US	−0.907**	–	
OS	0.951**	−0.733**	
z-BMI	−0.117*	0.141*	−0.085

z-BMI standardized body mass index

*$P < 0.05$, **$P < 0.01$

Discussion

Parents tended to underestimate the sugar content of common foods and beverages, in particular those with a "health halo," such as orange juice and fruit yogurt [16]. More than 80% of the parents underestimated the amount of sugar in orange juice and yogurt—frequently consumed by many children [17]—by, on average, seven sugar cubes. Seven sugar cubes represent more than 60% of these products' total sugar content. The sugar content of only the granola bar and the ketchup was generally over- rather than underestimated.

This is the first study to demonstrate that parental underestimation of sugar content is associated with childhood obesity. Above and beyond the influence of parental education and BMI, the underestimation of sugar was associated with a twofold increase in the likelihood of children being overweight or obese. We also found a dose–response relationship: that is, the more a parent underestimated the amount of sugar, the higher their child's BMI. We found a reversed (albeit not significant) association between overestimation and BMI. This suggests that it is not misestimation per se but specifically parental underestimation of sugar that is associated with children's overweight.

The main limitation of the present study is the use of cross-sectional data that does not permit firm conclusions about underlying mechanisms. One potential mechanism might be that those parents who underestimate the amount of sugar in certain foods and beverages (e.g., yogurt or juice) are less likely to monitor or regulate their child's consumption of these products. Thus, the child may be free to consume more of the products and, consequently, more sugar. Future studies should investigate this and other possible mechanisms such as the role of risk perception in the association between sugar underestimation and higher BMI.

Knowledge about sugar content may inform behavior [18]. Assuming future studies confirm the present findings and associations, the pertinent question will be how to compensate for systematically wrong intuitions about the sugar content of common foods and beverages. Intelligible front-of-package food labels could be one way to boost parents' knowledge about sugar [19]. Such smart labeling would complement other measures, some focusing on children (e.g., nutritional education in schools) and others targeting manufacturers and consumers (e.g., sugar tax).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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