

# Negative effects of sugar-sweetened beverages

Neugodni učinki pijač z dodanim sladkorjem

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## Izvleček

Naraščanje debelosti pri otrocih je delno povezano z uživanjem sladkih pijač (pijač z dodanim sladkorjem (PDS) in sadnih sokov). Le-te imajo visoko vsebnost sladkorja, nizek učinek sitosti in nepopolno nadomestilo za energijo, zato predstavljajo tveganje za spodbujanje pozitivne energijske bilance. Vsako dodatna PDS, ki jo otroci zaužijejo na dan, povečuje njihove možnosti, da postanejo debeli za 60 %. Drugi glavni neugodni učinki na zdravje sladkih pijač so: razvoj želje po sladkem okusu, slaba preskrba s hranilnimi snovmi, zmanjšanje kostne gostote, zlomi kosti, razvoj zobne gnilobe, visok krvni tlak, bolezni srca in ožilja ter diabetes tip 2. PDS so glavni vir dodanega sladkorja v prehrani slovenskih mladostnikov. Voda ne vsebuje energije in lahko podpira vzdrževanje zdrave telesne teže, če nadomesti sladke pijače. Zmanjšanje uživanja PDS lahko pomaga nadzorovati težo pri otrocih in odraslih. Potrebno je, da strategije na področju javnega zdravja vključujejo izobraževanje o vnosu pijač. Porabo PDS bi bilo potrebno odsvetovati, medtem ko naj spodbujanje pitja vode postane prednostna naloga.

## Abstract

The rising prevalence of obesity in children has been linked in part to the consumption of sugary drinks (sugar-sweetened beverages (SSBs) and fruit juices). They have high sugar content, low satiety effect and incomplete compensation for energy, so they pose a risk for promoting positive energy balance. Each extra serving of SSBs children consume per day increases their chance of becoming obese by 60 %. Other main negative health effects of sugary drinks are: the development of preference for sweet taste, poor nutrient supply, lower mineral density, bone fractures, development of dental caries, high blood pressure, cardiovascular disease and type 2 diabetes. SSBs are the leading source of added sugar in the diet of Slovenian adolescents. Water does not contain energy and may support a healthy weight status if it replaces sugary drinks. Cutting back on SSBs can control weight in children and adults. It is necessary that present public health strategies include education about beverage intake. Consumption of SSBs should be discouraged, whereas promoting the consumption of water should be made a priority.

## Sugary drinks

SSB is any beverage with added sugar (sucrose) or other caloric sweeteners such as high-fructose corn syrup, or fruit juice concentrates, all of which have similar metabolic effects.<sup>1,2</sup> Added (free/extrinsic) sugars are the sugars and syrups added to foods and beverages in processing or preparation (by the manufacturer, cook, or consumer) and include sugars naturally present in honey, syrups, and fruit juices, but not the naturally occurring sugars in fruits or milk. Free

sugar intake should be below 10 % of energy intake.<sup>3</sup> Examples of SSBs are flavoured/enhanced waters, ice tea, sports drinks, energy drinks, sweetened carbonated beverages, including soda, fruit drinks, fruit nectars, syrup beverages and sweetened tea.<sup>1,2</sup>

100 % fruit juices are not SSB. They contain 5–17 % sugar (23–71 kcal/100 ml).<sup>1,4</sup> The 4 major sugars in fruit juices are: sucrose, glucose, fructose, and sorbitol.<sup>5</sup> Table 1 shows the main groups of SSBs and fruit

juices with their range of energy and sugar content.<sup>4</sup>

## Negative health effects of sugary drinks consumption

**Development of sweet taste and food preferences from infancy:** At birth, all infants prefer sweet solutions to water. By 6 months of age, the preference for sweetened water is linked to the infants' dietary experience. Infants with regular intake of sugary drinks are primed to their sweet taste with a possible increased risk for later development of dental caries or obesity.<sup>5-7</sup> Parents play a vital role in the development of food preferences of children.<sup>8</sup>

**Major contributor to the obesity epidemic:** The form of dietary intake (fluid versus solid) is related to energy balance. The beverage food forms elicit a weaker compensatory dietary response than the matched solid food form (watermelon juice vs. watermelon). Total daily energy intake was 12.4 % higher on the days the beverage forms of high-carbohydrate foods were ingested, due to a weak effect on satiety.<sup>9</sup> People do not compensate well for the calories they consumed with liquids by eating less food.<sup>10-12</sup>

Intake of SSBs and fruit juices is associated with an elevated risk of weight gain and

obesity.<sup>7,13,14</sup> In a prospective, observational analysis of schoolchildren (n = 548), aged 11.7 (± 0.8) years, that were observed for 19 months, each additional serving of SSBs consumed per day, increased their chance of becoming obese by 60 %.<sup>6</sup> In short-term feeding trials in adults drinking SSBs and fruit juices before a meal was associated with 7.8 % and 14.4 % higher total energy intake compared to drinking water.<sup>13</sup>

**Diarrhoea, abdominal pain and growth faltering, especially in infancy:** High intakes of fruit juice can exceed the capacity for fructose absorption and induce diarrhoea, abdominal pain and growth faltering.<sup>15-17</sup>

**Poor nutrient supply and fractures:** Feeding infants with sugary drinks may replace human milk or infant formula intake, which may adversely affect nutrient supply.<sup>4</sup> Consumption of SSBs in children is associated with inadequate intake of calcium, iron, and vitamin A.<sup>18,19</sup> Low calcium intake during adolescence jeopardizes the accrual of maximal peak bone mass. A 5–10 % deficit in peak bone mass may result in a 50 % greater lifetime prevalence of hip fracture.<sup>20</sup> Cola-type beverages intake is negatively associated with bone mineral density and positively with bone fractures.<sup>7,21-23</sup> High phosphate content of cola leads to a change in the calci-

**Table 1:** Energy values, sugar content and cubes of sugar in sugary drinks (SSBs and fruit juices) sold on the Slovenian market (data from the computer programme "Open Platform for Clinical nutrition", OPEN)<sup>4</sup>

	energy (kcal/100 ml)		sugar (g/100 ml)		energy (kcal/500 ml)		sugar (g/500 ml)		sugar cubes* number/500 ml	
	min	max	min	max	min	max	min	max	min	max
Sugary drinks										
SSBs										
flavoured water	4	18	1	4	20	89	5	22	1	4
sports drinks	32	26	4	6	160	130	20	32	4	6
ice teas	20	40	5	10	102	199	25	49	5	10
energy drinks	45	49	11	13	225	245	55	65	11	13
sweetened carbonated beverages/soda	34	51	9	13	170	255	44	67	9	13
fruit nectars <sup>fn</sup>	24	60	5	16	122	300	27	79	5	16
Fruit juices <sup>fj</sup>	23	71	5	17	115	355	24	87	5	17

\*1 sugar cube = 5g; <sup>fn</sup>25–50 % fruit part; <sup>fj</sup>100 % fruit part

um-phosphorus ratio in the diet, which has deleterious effect on bone.<sup>20</sup>

**Dental Caries:** Sugar is a major dietary risk factor for the formation of dental caries. Sucrose is the most cariogenic sugar, because it can form glucans that enable bacterial adhesion to teeth and limit diffusion of acid and buffers in the plaque.<sup>24</sup> Consumption of SSBs is associated with increased risk of dental caries (sodas' high sugar content and acidity results in enamel erosion over time).<sup>25,26</sup>

**High blood pressure and cardiovascular disease:** Consumption of fructose and added sugars found in SSBs is associated with higher blood pressure<sup>27</sup> and a greater risk of cardiovascular disease in adolescents.<sup>28,29</sup>

**Type 2 diabetes:** Women consuming 1 or more SSB per day during 8 years had a 83 % greater risk of developing type 2 diabetes compared with those who consumed < 1 SSB/month.<sup>30</sup> Higher consumption of SSBs is associated with an increased risk for development of type 2 diabetes, possibly by providing excessive calories and large amounts of rapidly absorbable sugars.<sup>1,30</sup>

## Sugary drinks consumption in slovenian adolescents

In a national representative study, that was part of a larger project<sup>31-34</sup> we investigated dietary habits of Slovenian adolescents entering high school (n = 2,813; aged 15-16 years). The SSBs consumption in boys was 683 ml/day (44 % of beverages) and in girls 715 ml/day (41 % of beverages). Fruit juices consumption in boys was 114 ml/day (7 % of beverages) and in girls 102 ml/day (6 % of beverages). The SSBs intake was higher than the intake of milk and milk products together (513 g/day in boys; 479 g/day in girls).<sup>35</sup> SSBs contributed 9-10 % of daily energy intake of boys and girls and are the primary source of added sugars in the diet of adolescents.<sup>35,36</sup>

The intake of added sugars was (mean) 130 g/day in boys and 110 g/day in girls (16 % and 17 % of the daily energy intake), which exceeded the upper recommended limit<sup>3</sup> by 60 % in boys and by 70 % in girls.<sup>36</sup> Excessive

consumption of sugars has been linked with several metabolic abnormalities and adverse health conditions, as well as shortfalls of essential nutrients.<sup>37</sup>

In Health behaviour in school- aged children (HBSC) study, Slovenian 15-year-olds were at the top of 41 countries from Europe and North America in terms of the frequency of adolescents drinking soft drinks daily. Slovenian 11-year-olds were on the second, whereas 13-year-olds on the third place. The highest frequency of SSBs consumption on a daily basis in Slovenia was reported in 15-year-olds (boys and girls: 49 % and 39 %), followed by 13-year-olds (41 and 31 %) and 11-year-olds (36 % and 27 %), with prevalence being higher in boys.<sup>38</sup>

## Cutting back on SSBs can help control weight

Studies in children and adults have found that reducing SSBs consumption can lead to better weight control among those who were initially overweight.<sup>39,40</sup> In an 18-month randomized controlled trial of 4-11-year olds, replacing SSBs with non-caloric beverages significantly reduced weight gain and body fat.<sup>41</sup> A randomized, controlled pilot study investigated the effect of decreasing SSBs consumption on body weight in adolescents aged 13-18 years. Environmental intervention almost completely eliminated SSB consumption. The beneficial effect of reducing SSB consumption on body weight increased with increasing baseline body weight.<sup>39</sup> A school based education programme produced a modest reduction in the amount of SSBs consumed, which was associated with a reduction in the number of overweight and obese children.<sup>42</sup> A randomized, controlled cluster trial that promoted and provided water drinking in schools has shown that combined environmental and educational school-based intervention is effective in the prevention of overweight among children in elementary school.<sup>43</sup>

Reduction of SSB intake of 1 serving/day in adults (aged 25-79 years; n = 810) was associated with a weight loss (0.49 kg at 6 months; 0.65 kg at 18 months).<sup>44</sup>

Short-term studies showed that drinking water before a meal was associated with a lower energy intake over the course of the day compared with drinking SSBs or fruit juices.<sup>13</sup> Three large prospective cohort studies of adults without obesity and chronic diseases at baseline showed that increasing water intake in place of SSBs or fruit juices was associated with lower long-term weight gain. Substitution of SSBs and fruit juices with water and other beverages (coffee and modestly also diet beverages) was associated with less weight gain over time (over each 4-year period). Increasing water intake *per se* was associated with less weight gain in long-term prospective cohorts. There is a long-term benefit of replacing SSBs or fruit juices with water (or coffee, tea, diet beverages or low-fat milk), mainly due to decreased total energy intake.<sup>45</sup>

## Recommendations for water intake

The most recommended fluid for infants, after introduction of solid foods, is water. Infants should avoid consumption of sugary drinks (beverages with sugar, syrup, honey, sugar substitutes or sweeteners; examples: tea with sugar, fruit juice as a drink) in bottles and beakers.<sup>46,47</sup> The recommended beverages for children and adolescents are: water, mineral water or/and tea (fruit or herbal) without added sugar. Fruit juices may only be added to water in small amounts to improve the taste.<sup>48</sup> Fruit juices lack fibre, are consumed more quickly and do not promote the desirable behaviour of eating

whole fruits. Fruit juices have no nutritional advantages over whole fruits. Children should be encouraged to eat whole fruits.<sup>5</sup> Table 2 represents the amount of water that the children should drink per a day. This guiding values represent the average basic water needs of children, which are increased for example during physical activity, on hot summer days as well as in the case of fever.<sup>49</sup>

## Tips for drinking for children and adolescents

Water keeps children and adolescents hydrated best. Assure that they can get water throughout the day. Teach them to drink water at any time they are thirsty. Provide that children in kindergartens and schools have a source of hygienic, fresh tap water or water fountains available.<sup>50</sup> Children participating in vigorous exercise should drink water before, during, and after exercise. The use of sports drinks in place of water is unnecessary for children or adolescents engaged in routine physical activity for less than three hours in normal weather conditions. Small amounts of sports drinks may be appropriate when children are participating in a prolonged vigorous physical activity in hot, humid conditions for more than one hour.<sup>51</sup> Sports drinks are appropriate only for athletes or individuals engaging in a prolonged vigorous physical activity (i. e. football training during the summer months, marathon training and races, competitive tennis matches and long cycling races) and/or those activities performed at high temperatures and humidity.<sup>52</sup>

**Table 2:** Guideline values for water consumption in drinks per day<sup>49</sup> and calculated in number of glasses

Age	Recommended amount of water to drink (ml/day)	Calculated in glasses (N° of 2 dcl glasses/day)
1 to < 4 years	820	~ 4
4 to < 7 years	940	~ 5
7 to < 10 years	970	~ 5
10 to < 13 years	1.170	~ 6
13 to < 15 years	1.330	~ 6.5
15 to < 19 years	1.530	~ 7.5

In a pilot school-based intervention project “Reducing intake of SSBs in children and adolescents”, shortly entitled “Water wins!”, in Slovenia we aim to raise the awareness among school children aged 11 to 14 years, their parents, school headmasters, teachers, heads of catering and cooks, about the importance of replacing SSBs and fruit juices with water. Four schools were randomly selected for testing different environmental and educational interventions.<sup>50</sup>

## Conclusions

The consumption of SSBs in Slovenian adolescents is too high. On any given day, almost half of the 15-year old boys and 39 % of girls in Slovenia consume SSBs. SSBs contribute 9 % and 10 % of total energy intake in adolescent boys and girls respectively, representing the primary source of added

sugars in the diet of adolescents.<sup>35,36</sup> Water is the best drink for hydration. Parents, educators and paediatricians should promote the popularity of water among children and adolescents. It is vital that children drink enough water during the day. Sport drinks are recommended only for intense physical activities lasting over an hour. Fresh and clean water should be available to children and adolescents in kindergartens and schools.

The weight of epidemiologic and experimental evidence indicates that a greater consumption of SSBs is associated with weight gain and obesity. Public health strategies should discourage consumption of sugary drinks as part of a healthy lifestyle. Changing the beverage drinking pattern and improving the access to more water and less sugary drinks could be efficient and cost-effective, and should be prioritized in obesity prevention strategies.

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