DETERMINANTS OF SOFT DRINK CONSUMPTION AMONG CHILDREN AND ADOLESCENTS IN DEVELOPED COUNTRIES – A SYSTEMATIC REVIEW

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SUMMARY

Objectives: Soft drinks are a major component of daily caloric and sugar intake. This is especially true for children and adolescents. The WHO as well as many other institutions currently recommend to increase research on the determinants of soft drink consumption. We submit a current systematic review on this topic.

Methods: In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, we included all quantitative observational studies that comprise samples from developed countries in the age range 0–18 years and are listed in PubMed, Sociological Abstracts and the Social Sciences Citation Index. Publication period was not limited. The second and the last author screened all 10,392 hits independently with both reviewers being blinded. Interrater reliability (agreement and Cohen's kappa) was 97%/0.73 for the selection of titles, 91%/0.83 for abstracts and 91%/0.80 for full texts.

Results: Results of 43 included studies, published between 2001 and 2017, show that children and adolescents consuming soft drinks tend to be older, male and of lower social status. Important contextual factors promoting consumption include constant availability at home, at schools or elsewhere as well as restrictions by parents and rules concerning drinks during meals or generally at home. The association between media consumption and soft drink consumption is particularly striking. Other factors in the food environment (choice of food and alternative drinks at home, having meals together, motivation, knowledge about nutrition and healthy eating) are of minor importance.

Conclusions: When introducing interventions parents should play a major role because they serve as physical and social gatekeepers for this early risk factor of juvenile obesity.

Key words: soft drinks, sweetened beverages, soda, child health, obesity, systematic review

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INTRODUCTION

The need to promote healthy eating habits has intensified in recent years as a result of the growing global epidemic of obesity among young people. Although the causes of obesity are complex, soft drinks have been identified as an important factor in the observed rise in the prevalence of obesity, particularly among children and adolescents (1). Longitudinal data suggests that as little as one additional serving per day is associated with a greater risk of increased BMI among adolescents (2). This is not surprising since, to a large extent, these empty calories represent energy added to, not displacing, other dietary intake (3). As is already known, compared to other forms of calories, soft drinks do not lead to feelings of satiety, but rather increase hunger levels and prompt food consumption after drinking (2, 4).

Furthermore, in addition to playing a role in the development of obesity, excessive consumption of soft drinks has consistently been associated with the development of metabolic syndrome, type 2 diabetes, poor oral health (e.g. dental caries), and the displacement of milk and calcium in the diet (5). In addition to this, the phosphoric acid found in sweetened cola beverages in particular has been found to cause erosive lesions and may therefore increase bone loss (6).

The World Health Organization has therefore emphasized the "need to evaluate different behavioural-change approaches to promote the reduction of free sugars intake; in particular the intake of sugar-sweetened beverages" (7). Since unhealthy dietary habits such as soft drink consumption are formed during childhood, it is therefore important to understand the factors influencing these behaviours in children and adolescents in particular (8). This detailed understanding of the relative importance of determinants and correlates is an essential prerequisite in order to prioritise the factors that have the greatest potential to reduce soft drink consumption and to inform the development of effective interventions (9).

To date, only one systematic review has been carried out in this field, looking at the consumption of sugar-sweetened beverages (SSBs) by young children (8). However, in addition to the typical range of soft drinks (non-alcoholic carbonated and non-carbonated sweetened beverages), this review also includes many other sweetened beverages such as energy drinks, sports drinks, tea and coffee drinks. Furthermore, this review limits its literature search to young children aged 0–6 years and publications from the beginning of 1999 to mid-2014.

The aim of this systematic review is therefore to summarise the current state of global research on the determinants and correlates

affecting soft drink consumption by children and adolescents applying the classification used by Pabayo et al. (10), with a focus on developed countries.

MATERIALS AND METHODS

Definitions

There is currently no internationally accepted standard definition of what constitutes a 'soft drink'(8). It was therefore a challenge to specify the definition for this review prior to selecting studies. On the one hand, it was important to ensure that the definition was not too broad, as this would lead to watered-down results, yet at the same time it should not be too narrow so as to exclude key studies. Therefore, the definition of soft drinks used here included the typical range of non-alcoholic, carbonated and non-carbonated sugar-sweetened beverages (e.g., cola, lemon and orange sodas, etc.). If a study also included fruit drinks, artificially sweetened beverages ("diet" or "zero" sodas), non-alcoholic cordials, Kool Aid and the like in their classification of soft drinks, we included it in this review. After all, basic health risks that are associated with soft drinks (such as development of a preference for sweet tastes, stimulation of appetite, displacement of milk and calcium in the diet) are still equally applicable when these versions – including sugar-free variants – of soft drinks are consumed (11).

However, if a study included coffee or tea-based drinks (e.g., iced coffee, iced tea) or energy or sports drinks in their classification of soft drinks, we excluded it from the review. Although these beverages usually contain similarly large amounts of added sugar (12), further studies have shown that adolescent consumers and their parents tend to subjectively view the health effects of these particular types of sweetened beverages differently than other soft drinks, to the contrary, they exhibit positive associations with several healthy lifestyle practices (4, 12). As we think that studies comprising these specific types of beverages are difficult to compare with studies that only included typical soft drinks like cola, lemon and orange sodas, we excluded them for methodological reasons.

Information Sources

The methods used in this review are based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (13). We searched the PubMed, Sociological Abstracts (via Proquest) and the Social Sciences Citation Index (via Web of Science) databases using the keywords "soft drink" or "sweetened beverage" alternatively. Both of these are established entry terms from the Medical Subject Headings (MeSH) thesaurus. In addition, we also conducted searches using the German translations of these keywords. The complete database search was carried out on 16 March 2019.

Eligibility Criteria

Publications were considered eligible if they met the following criteria: quantitative observational study – e.g., prospective or retrospective, cross-sectional or longitudinal; also baseline data of a randomised controlled trial or another kind of experiment according to the definition of Altman (14), data from nations with developed economies according to the United Nations (15), study sample between 0–18 years of age, published in English or German, consumption of soft drinks or sweetened beverages as dependent variable (main outcome or one of the main outcomes in accordance with the above definition), and determinants or correlates of consumption as independent variables.

Studies were subsequently ruled out if they met any of the following criteria: letter, commentary, case report, review, meta-analysis, qualitative study or mixed-methods study as type of publication, study at macro level (campaign report, trend and market analysis, sales and tax report, analysis of structural measures at macro level – e.g., sugar tax, food marketing), study focussed on soft drink consumption as a risk factor for diseases (e.g., type 2 diabetes, depression, mental health) or for other outcomes (e.g. BMI), and sample that included adults.

Study Selection and Evaluation

The keywords were deliberately kept general and not restricted to the paper title or abstract, i.e. [tiab]. This was done in order to generate the biggest possible hit list; each relevant study was then selected by means of manual screening. There were no restrictions in terms of publication date.

All identified articles were imported into Rayyan, a web-based tool for systematic reviews (16). The 10,392 articles were initially reduced to 4,961 by excluding duplicates. Two of the authors (LS and NO) then carried out an independent screening of all articles. Using a multi-step selection process including review

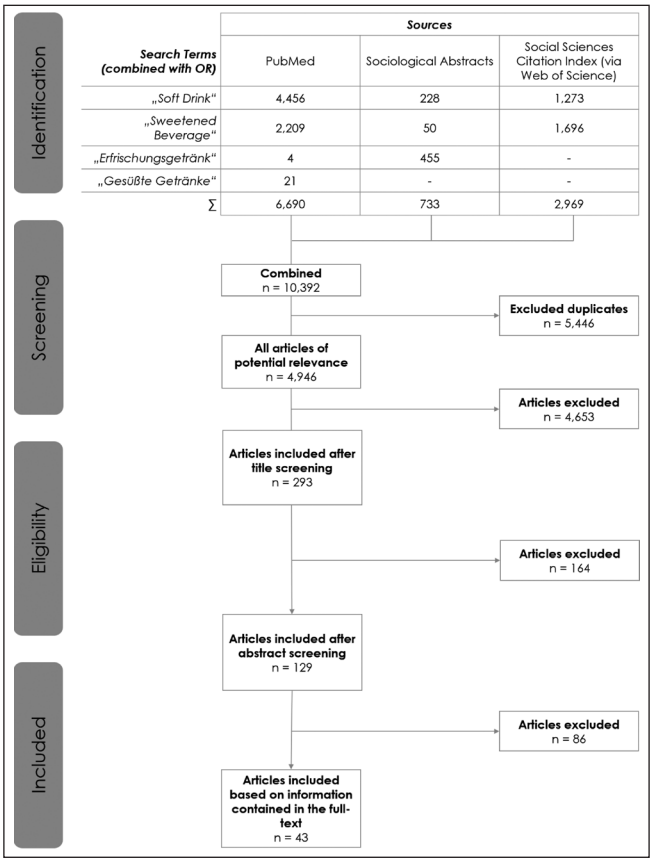

Fig. 1. *Flowchart of systematic literature selection process.*

of the title, abstract and full-text article (Fig. 1), both reviewers decided independently and blinded whether each study met the inclusion criteria. After each selection step, we discussed decisions regarding the inclusion or exclusion of a study. Details of the selection process are shown in Figure 1.

In most cases both reviewers agreed during the multi-step selection process for titles (97%), abstracts (91%) and full-text articles (91%). Cohen's kappa (κ) as a measure of inter-rater reliability was 0.73, 0.83 and 0.80, respectively, which reflects substantial to almost perfect agreement (17). The few cases in which the reviewers disagreed about inclusion criteria were additionally evaluated by the first author (SS) and then discussed at team meetings until a consensus was reached.

Data Collection Process

Each study was evaluated using a standardised, pretested extraction form. For the purposes of quality assurance, two authors (LS and NO) reviewed all studies finally included in the review twice to ensure agreement and consistency in data extraction and reporting. We extracted information from the full-text articles about the sample characteristics (e.g., study region, age range, sample size, data generation period) and the operationalisation of beverage consumption.

Synthesis of Results

We performed a non-quantitative synthesis of all socio-demographic, environmental and behavioural determinants or correlates of soft drink consumption. We used the final statistical model within each publication. The final model was deemed to be the most comprehensive statistical analysis, such as the regression with the largest sample size or which accounted for the most predicting factors. Where analyses were stratified according to boys and girls with a final analysis of the total sample, the latter analysis was used for the purposes of this review. Where multiple regressions were carried out for various different possible outcomes, we selected the analysis that best matched our above-specified definition of "soft drinks". For example, if five regressions were conducted for the outcomes "regular soft drinks", "diet drinks", "sports drinks", "sweetened milk", and "all sweetened beverages" in which all other conditions were equal, the first regression was selected for the following overview of results.

The summary of results includes all independent variables that were reported in the original model. Interaction effects that were additionally calculated in a very small number of articles have not been depicted for the sake of clarity.

In accordance with the suggestion from Pabayo et al. (10), we have grouped the determinants within this summary of results into socio-demographic, environmental and behavioural factors; subcategories have been created within these main categories using standard terminology. Conceptually similar exposures were combined. For each potential determinant, findings from individual studies were categorised as "positive association", "negative association" and "no association or mixed results" with soft drink consumption. Studies were assigned to one of these three categories based on the predefined significance level of $p \leq 0.05$. It was not possible to conduct an additional meta-analysis due to the heterogeneity between studies (particularly in terms of study design, participant characteristics, determinants and correlates) and analyses (statistical evaluation process).

RESULTS

Study Characteristics

In total, 43 studies were identified which met our inclusion criteria. The key characteristics of these studies are summarised in Table 1.

The studies on the determinants for soft drink consumption were mainly conducted in Europe (n = 22) and the USA (n = 16). Three studies were from Australia and two from Canada (Table 1). The studies were published between 2001 and 2017. The furthest that the underlying datasets for these studies date back is the late nineties.

Depending on the study, the age of the children and adolescents surveyed ranged from 0 to 18 years. Sample sizes summed to a total of 264,485 participants and ranged in size from 69 to more than 110,000 participants with a median sample size across all studies of 1,336 participants. Of 43 studies, 14 study samples were population-based and 16 were carried out in schools. In terms of the methods used, most of the studies reviewed presented multiple linear (n = 12) or logistical (n = 15) regression analyses (Table 1).

The lack of a standard definition for soft drink consumption was clearly reflected in the very different ways in which the investigated outcomes were operationalised. Firstly, different types of beverages were grouped together (e.g., "coke or other soft drinks that contain sugar", "sweetened soft drinks" or "caloric carbonated and non-carbonated soft drinks"). Secondly, within the relevant statistical analyses, these outcomes were sometimes listed as dummy variables ($\geq$1 time/day, $\geq$4 times/week, etc.), sometimes as ordinal variables and sometimes as continuous variables (Table 1).

Furthermore, it should be noted that important information concerning methodology was lacking in many cases. In five studies, the age of the participants was only given as an arithmetic mean without a minimum/maximum range. In five other studies, it was only possible to gauge the age of the participants based on information about which school year groups were surveyed. Information about when data collection was carried out was completely missing in five further studies.

Results of Individual Studies

With regard to socio-demographic groups, soft drink consumption generally occurred more among older children than younger ones and more among boys than girls (Table 2). These are the key findings in terms of horizontal inequalities. Studies that found no significant correlation with age tended to be based on adolescents instead of children, suggesting that a plateau effect develops during adolescence.

Where vertical inequalities – typical socioeconomic status (SES) differences – were found, these were always linked to a negative family social gradient. As such, soft drink consumption was considerably higher in families with a low level of education or low SES (Table 2).

Table 1. *Characteristics of included studies in this systematic review*

Author	ID	Study region	Age range (mean age) of target persons[a]	Sample size[b]	Population-based sample	Data generation period[b]	Statistical method[b]	Operationalisation of beverage consumption
Vereecken et al., 2005 (1)	1	Europe	11–15	114,558	Yes	2001–2002	Multilevel logistic regression analysis	Coke or other soft drinks that contain sugar (daily consumption)
Evans et al., 2010 (28)	2	USA	Unspecified (grades: 4, 8, 11)	23,190	Yes	2004–2005	Logistic regression analysis	Regular sodas (≥ 1 time/previous day)
Ranjit et al., 2010 (12)	3	USA	Unspecified (middle and high school children)	15,283	Yes	2004–2005	Linear regression analysis	Regular non-diet sodas or soft drinks (servings/previous day)
Verzeletti et al., 2010 (27)	4	Belgium, Italy	11–16	14,407	No, school sample	2005–2006	Logistic regression analysis	Coke or other soft drinks that contain sugar (daily consumption)
Danyliw et al., 2011 (29)	5	Canada	2–18	10,038	Yes, national cross-sectional survey	2004	Cluster analysis	Regular soft drinks (incl. non-alcoholic beers; g/day)
Terry-Mc Elrath et al., 2013, (30)	6	USA	Unspecified (grades: 8, 10, 12)	9,284	Yes	2010–2011	2-level hierarchical linear analysis	Regular non-diet soft drinks (cans, bottles/day)
Pérez-Farinós et al., 2017 (31)	7	Spain	6–9	9,093	Yes	2011, 2013	Logistic regression analysis	Sugar containing soft drinks (≥ 4 times/week)
Bjelland et. al., 2013 (32)	8	Norway	1–7	9,025	Yes, prospective population-based pregnancy cohort	1999–2008	Bivariate analysis	Sugar-sweetened beverages (incl. cordials; times or glasses/week)
Scully et al., 2017 (19)	9	Australia	12–17	7,835	Yes	2012–2013	Logistic regression analysis	Soft drinks (non-alcoholic sugar-sweetened carbonated drinks; ≥ 4 cups/week)
Pinket et al., 2016 (33)	10	Europe	3–5	6,776	No, kindergartens and pre-school sample	2012	Multilevel linear regression analysis	Soft drinks (ml/day)
Miguel-Berges et al., 2017 (34)	11	Europe	3–5	6,431	No, kindergartens and pre-school sample	2012	General linear model	Fizzy drinks (soft drinks, carbonated beverages, light soft drinks; portions/day)
Nickelson et al., 2010 (35)	12	USA	Unspecified (grades: 6–8)	4,049	No, school sample	2004	Logistic regression analysis	Soft drinks (≥ 1 time/day)
Bere et al., 2008 (3)	13	Norway	(15.5)	2,870	No, school sample	2005	Logistic regression analysis	Carbonated soft drinks (≥ 2 times/week)
Hilsen et al., 2013 (36)	14	Norway	(15.5)	2,870	No, school sample	2005	Bivariate analysis	Sugar-sweetened soft drinks (times/week)
Denney-Wilson et al., 2009, (25)	15	Australia	11–16	2,719	No, school sample	2004	Logistic regression analysis	Soft drinks (≥ 250 ml/day)
Dodd et al., 2013 (37)	16	USA	6–18	2,314	Yes	2004–2005	Bivariate analysis	Sugar-sweetened non-diet soda (consumption at any point during the day)
Storey et al., 2006 (38)	17	USA	6–11	2,124	Yes	1999–2002	Linear regression analysis	Regular carbonated soft drinks (g/day)

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Table 1. *Characteristics of included studies in this systematic review*

Author	ID	Study region	Age range (mean age) of target persons[a]	Sample size[b]	Population-based sample	Data generation period[b]	Statistical method[b]	Operationalisation of beverage consumption
Elfhag et al., 2007 (11)	18	Sweden	10–13	1,853	Yes	2000	Bivariate analysis	Sugar-sweetened soft drinks (highest reported consumption)
Garnett et al., 2013 (5)	19	USA	2	1,785	Yes	2004–2007	Logistic regression analysis	Sugar-sweetened beverages (soda pop, Kool-Aid, fruit drinks; ≥ 1 day/week)
Pabayo et al., 2012 (10)	20	Canada	4–5	1,760	No, convenience sample	2005–2007	Log-binomial regression analysis	Soft drinks (any regular consumption in an average week; > 0 cups)
He et al., 2008 (39)	21	UK	4–18	1,688	Yes	1997	Bivariate analysis	Sugar-sweetened soft drinks (g/day)
De Coen et al., 2012 (40)	22	Belgien	2–7	1,639	No, pre-school and school sample	Unspecified	Mediation analysis	Soft drinks (ml/day)
Bjelland et. al. 2011, (24)	23	Norway	11	1,528	No, school sample	2007	Bivariate analysis	Soft drinks with sugar and sugar-sweetened fruit drinks (dl/day)
Elfhag et al., 2008 (11)	24	Sweden	12	1,441	Yes	2000	Linear regression analysis	Sugar and artificial sweetened soft drinks (days/week)
Rey-López et al., 2011, (41)	25	Europe	12–17	1,336	No, school sample	2006–2007	Bivariate analysis (chi^2 test)	Soft drinks (consumption while watching TV)
Bogart et al., 2017, (2)	26	USA	11–14	1,313	No, school sample	2009–2011	Linear regression analysis	Sodas (glasses/day)
Pettigrew et al., 2015 (9)	27	Australia	8–14	1,302	No, web panel	Unspecified	Linear regression analysis	Soft drinks (frequency of consumption)
Van Ansem et al., 2014 (20)	28	Netherlands	8–12	1,266	No, school sample	2008–2011	Linear regression analysis	Sugar-sweetened beverages (servings/week)
Gebremariam et al., 2016, (42)	29	Norway	(13.6)	742	No, school sample	Unspecified	Linear regression analysis	Carbonated sugar-sweetened soft drinks (dl/week)
Kassem et al., 2003 (6)	30	USA	13–18	707	No, school sample	1999	Bivariate analysis	Sodas (glasses, cans, bottles/day, week, month)
Grimm et al., 2004 (43)	31	USA	8–13	560	No, mail-in and online sample	1999	Logistic regression analysis	Soft drinks (≥ 5 times/week)
Cullen et al., 2002 (44)	32	USA	Unspecified (grades: 4–6)	504	No, school sample	1998	Bivariate analysis (analysis of variance)	Sweetened beverages (soft drinks, fruit flavoured drinks; ounces/day)
Melbye et al., 2016 (26)	33	Norway	13–15	440	No, school sample	2013	Mediation analysis	Sugar-sweetened beverages (incl. cordials and carbonated soft drinks with sugar; dl/week)
De Bruijn, van den Putte, 2009 (45)	34	Netherlands	(14.6)	312	No, school sample	2008	Bivariate correlation and structural equation model	Sugar-sweetened soft drinks (glasses, cans/day, week)
Hasselkvist et al., 2014, (46)	35	Sweden	13–14	227	No, patient sample at Public Dental Health Service	2005–2007	Logistic regression analysis	Carbonated soft drinks (highest vs. lowest tertile of average weekly consumption)

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***Table 1.** Characteristics of included studies in this systematic review*

Author	ID	Study region	Age range (mean age) of target persons[a]	Sample size[b]	Population-based sample	Data generation period[b]	Statistical method[b]	Operationalisation of beverage consumption
De Bruijn et al., 2007 (47)	36	Netherlands	12–18	208	No, sample from family practice centres	2003	Linear regression analysis	Soft drinks containing sugar (glasses, cans, bottles/day or week)
Fisher et al., 2001 (48)	37	USA	4–6	197	No, convenience sample	Unspecified	Structural equation model	Caloric carbonated and non-carbonated soft drinks (frequency of consumption)
Zahid et al., 2017 (49)	38	USA	9–12	194	No, convenience sample	2014	Logistic regression analysis	Sugar-sweetened beverages (soda pop and fruit flavoured drinks; daily intake)
Sweetman et al., 2008 (50)	39	UK	(11.2)	173	No, follow up of a study sample	2004	Linear regression analysis	Sweetened soft drinks (e.g., Coca Cola; frequency of consumption)
Sdrali et al., 2010 (51)	40	Greece	13–16	149	No, school sample	2008–2009	Logistic regression analysis	Cola drinks containing sugar (≥ 2 times/week)
Dennison et al., 2015 (52)	41	USA	7–13	124	No, sample from summer camp	2013	Bivariate analysis (t test)	Sugar-sweetened beverages (kcal/day)
Harris et al., 2015 (53)	42	USA	3–13	102	No, convenience sample	Unspecified	Hierarchical linear regression analysis	Sugar-sweetened beverages (frequency of consumption in a typical day)
Nickelson et al., 2014 (54)	43	USA	0–5	69	No, convenience sample	2009–2010	Logistic regression analysis	Sodas (regular intake)

Sorted by sample size; [a]Arithmetic mean reported where age range not given; [b]Considered in this review, see Methods section of this systematic review.

With respect to environmental factors, social-ecological theory differentiates between the physical and the social environment. It would seem that direct accessibility and availability of soft drinks are the most reported factors when it comes to the physical environment in which soft drinks are consumed (Table 2). It would appear that if a child is always given a glass of lemonade at lunch, a bottle of coke is always on the dinner table in the evening, there is usually a cold bottle of soda in the fridge or the drinks machines and dispensers at school are filled with soft drinks, these physical conditions have a decisive influence on actual consumption. In contrast, findings on the significance of less specific determinants and correlates such as alternative drinks, other elements of the food environment and information about the home environment are scarce and inconsistent (Table 2).

When considering the social environment, it is noticeable that many studies have investigated the role of the parents as the central agents of socialisation for children and adolescents. Of all family-related factors, it was found that children's consumption of soft drinks is closely associated with how their parents act as role models and which rules, limitations and agreements are imposed. Relevant are the examples set by the parents regularly drinking soft drinks on certain occasions and whether the parents set clear rules for their children (e.g., table rules, daily limits, purchase bans, etc.). Data on all other parental characteristics and the underlying family environment is otherwise inconsistent. Here, too, it would seem that other less specific factors, such as parental nutrition knowledge, eating family meals together regularly or parental encouragement, support and practice of healthy eating habits do not play a distinct role.

Findings on behavioural determinants support this impression. Whilst the attitudes and habits of children and adolescents regarding soft drinks clearly determine their consumption, it would seem that there is an unclear relationship between their attitudes and habits regarding healthier food and drink choices and their soft drink consumption (Table 2). Of the other behaviour-related factors investigated, the one that really stands out is a clear positive association between media use (television, computer, smartphone) and soft drink consumption.

DISCUSSION

Summary of Findings

Our review of 43 studies on the determinants of soft drink consumption in developed economies highlights the following key findings. The investigation of the determinants of soft drink consumption is a relatively young area of research with potential for development in terms of methodology. Most of the relevant studies were conducted recently and are often not designed to be representative. Generally speaking, soft drinks are more likely to be consumed by older children than younger ones, boys rather than girls and rather by children and adolescents with a low SES than a high one. Important contextual factors governing consumption include the constant accessibility and availability of soft drinks at home and at school as well as the behavioural modelling, limitations and rules set by the parents. There is a particularly strong correlation between media use and soft drink consumption. Lastly, it is noticeable that the overall surroundings, i.e., general food

Table 2. *Socio-demographic, environmental and behavioural determinants and correlates of soft drink consumption*

Determinants	Empirical findings		
	Positive association	Negative association	No association or mixed results[c]
Socio-demographic determinants			
Horizontal socio-demographic determinants			
Age group	1, 2, 8, 12, 27, 32, 43	6	9, 13, 20, 34
Gender (female)		1, 2, 6, 9, 13, 14, 23, 25, 29, 35, 38, 40	8, 12, 17, 20, 27, 34, 41
Ethnicity[a]			(2, 6, 12, 16, 17, 19, 32, 34)
Vertical socio-demographic determinants			
Socioeconomic status		6, 9, 19, 22	1, 2, 20, 27, 32, 42
Parental or caregiver's education		6, 19, 23, 28, 40	8, 27, 29, 42
Children's educational aspiration		14	13
Pocket money	9		
Environmental determinants			
Physical environmental determinants			
Accessibility and availability of soft drinks (e.g., at home or in school)	9, 10, 12, 13, 15, 22, 26, 28, 29, 31, 38		20, 23
Accessibility and availability of healthy alternatives (e.g., water[i], milk[ii], fruit and vegetables[iii])		10[i]	24[iii], 38[ii]
General healthy food environment		42	29
Residing in urban area		19	2, 9
Other characteristics of home region[b]			(1, 6)
Advertising			40
Social environmental determinants			
Parental age	27	19	42
Parental BMI	19		27
Single-parent family	40		
Communal family meals			4
Obligation rules at the table			4
Parental rules (e.g., restrictions, limits)		4, 10, 12, 22, 29, 36	33
Parental encouragement, support and practice for healthy eating		37	10, 24, 33, 38, 42
Positive parental attitude towards soft drinks	27, 35		26
Parental beverage nutrition knowledge			10, 38
Soft drinks used as reward			10
Parental self-efficacy	10, 35		
Day care			20
Exclusive breast-feeding		19	
Modelling of significant others (e.g. parents) concerning soft drink consumption	13, 23, 24, 26, 27, 28, 29, 31, 36, 37, 42		9, 15, 22, 34, 38, 40

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Table 2. *Socio-demographic, environmental and behavioural determinants and correlates of soft drink consumption*

Determinants	Empirical findings		
	Positive association	Negative association	No association or mixed results[c]
Behavioural determinants			
Eating behaviour			
Healthy eating behaviour	13, 24	4, 12, 32, 35	3, 9, 15, 20, 38, 40
Eating out	19		
Restrained eating		18, 24	
Emotional or external eating			18
Meals and snacking while watching TV	4		
Salt intake	21		
Positive attitude towards healthy beverages			8, 41
Positive attitude towards soft drinks	9, 13, 20, 31, 36, 39		15, 34
Intention to drink soft drinks	30		
Intention to limit soft drink consumption			34, 36
Perceived behavioural control or self-efficacy (concerning soft drink consumption)		34	29, 36
Habit strength (concerning soft drink consumption)	34		
Soft drink-related knowledge		40	
Pestering	27		
Other health-related behaviour			
BMI			9, 16, 18
Physical activity		35, 40	3, 9
Screen time	3, 4, 7, 9, 11, 20, 25, 31, 34, 35		19, 27
Intention, attitude, norms, behavioural control, habits concerning watching TV			34
Quiet play			11
Sleep duration		9	7
Personality (“Big 5”)			33, 36

[a]In these studies, at least one specific ethnic group was compared with another specific ethnic group. For reasons of readability, no further information is included here, please refer to the original source for more details.
[b]Please refer to the original source for further details.
[c]Where inconsistent correlations are reported within a publication, these are indicated in this column.
Danyliw et al., 2011 (29) reported cluster analyses without descriptive, association or correlation analyses and is therefore not listed here.
Grouping of determining factors is based on the suggestions made by Pabayo et al., 2012 (10).

environment, shared family meals, parental nutrition knowledge, and encouragement of healthy eating, seem to be of secondary importance.

Limitations

In interpreting the results from this systematic literature review, it is important to consider several limitations.

Firstly, we cannot exclude the possibility of retrieval or publication bias. We chose not to include further databases or “grey literature”. Although non-peer reviewed publications have the potential to provide valuable insights in this area, the quality of methods applied to data collection, analysis and interpretation can vary substantially, further adding to the heterogeneity we observed.

Secondly, as we only focussed on articles written in English and German, we are thus unable to rule out language bias.

Thirdly, the direct comparison of available studies on the determinants and correlates of soft drink consumption is hampered by the heterogeneity seen across studies, in particular in terms of study design, sampling procedure and operationalisation of drink consumption. Criticism could be made in particular of the criteria that we chose and justified in the Methods section for deciding which outcome definition of “soft drink consumption” would lead to inclusion or exclusion from the review. Future systematic reviews may choose to select different criteria.

Fourthly, due to the exclusion of coffee drinks, sports drinks and energy drinks for reasons described at the beginning of this article we cannot make any statements about these categories

of beverages. These beverages should be subject to a separate scientific investigation.

Finally, it is also important to consider that there is a risk of residual confounding in all 43 studies due to unmeasured but relevant predictors and the well-known social desirability bias when giving details about problematic nutritional behaviour.

The strengths of this review include the breadth of its scope, that is, the large number of publications that were screened without the use of very restrictive keywords and without restricting selection to a certain publication period. Furthermore, we generally achieved good to very good kappa coefficients for our study selection procedure. Last, but not least, this is the first systematic review that examines this – we believe – very important causative condition behind the juvenile obesity epidemic and covers the entire age range from childhood to adolescence.

Interpretation in the Context of Other Evidence

Previous literature explains the higher level of consumption of soft drinks observed in older children by pointing to their increasing autonomy and greater disposable income, e.g. in the form of pocket money (3, 9, 18–20). The fact that male children and adolescents tend to consume soft drinks more frequently and in greater volumes than females is often ascribed to boys generally requiring a higher energy intake due to their higher body weight and higher resting metabolic rate (1). However, we do not believe this changes the fact that this increased energy demand is best fulfilled with healthy food. Discussions have also addressed additional reasons behind the higher levels of consumption among male adolescents such as a lower degree of health consciousness, less concern with their appearance and gender specific socialisation (1).

It is our view that the negative social gradient with regard to soft drink consumption may result from parental SES-specific education, role model function and parenting style. Alternatively, Garnett et al. (5) suggest a parental motive for this finding, namely that the introduction of soft drinks may be a mechanism for coping with food insecurity and that they are utilised as a vehicle to quell behavioural agitation (5).

These considerations indicate the formative influence that parents have on the consumption behaviour of their children. They act as nutritional gatekeepers, role models and supporters of healthy eating. Parents are responsible for their children's food and beverages choices because children have little control over purchases and therefore over the food that is available within the home (21). Adolescents and, to an even greater extent, children typically tend to eat what is available in the household (22). Interestingly, it seems that mothers rather than fathers play a key role in soft drink consumption. Thus, estimations regarding the accessibility of soft drinks within the family home tend to correspond more closely between mother and child than between father and child, indicating that mothers have better knowledge than fathers of the food selection actually available in the home (23). Other publications emphasize the role of the mother in particular as a role model for their children's dietary behaviour (24, 25). A child's soft drink consumption is thus more closely correlated to that of the mother than that of the father (24). This is equally true for both girls and boys (22). Studies on regulatory food parenting have also shown that mothers tend to be more active in monitoring, regulating and controlling their children's eating habits than fathers (26).

Parents are not only able to influence consumption of soft drinks and other foods, but also media use. This is significant as there is a strong correlation between soft drink consumption and media consumption (e.g., television, computer use, smartphone, game console). Individual studies have already observed this correlation among primary school children (21) and even in preschool aged children (5, 10). One particularly interesting study differentiated television consumption by weekday and found a particularly strong correlation with soft drink consumption on weekends (9). It is assumed that one key reason for this is the longer exposition times, thereby leading to longer distraction and interruption of physiological food regulation, e.g. satiety cues (19, 27). The latter argument is supported by evidence that snacking while using a computer is also linked to a significant increase in soft drink consumption (27).

CONCLUSIONS

This systematic review provides a summary of the current state of literature on the determinants and correlates of soft drink consumption as a starting point for future interventions. Health and health inequalities start to develop very early in life due to the complex interactions of cumulative risks and resources at the individual and the environmental level. Sweetened beverages are one piece of this puzzle. This review shows that various dimensions of an unhealthy lifestyle occur accumulatively. Our findings call for complex, multi-level interventions and highlight the central role played by a person's social context – their home environment in particular. Thus, parents could present a useful target of intervention. In addition to reducing the consumption of unhealthy SSBs, interventions also need to address other unhealthy lifestyle habits that go hand in hand with drinking SSBs, such as media use and low physical activity.

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Conflict of Interests

None declared

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