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The patterns and position of snacking in children in aged 2–12 years: A scoping review

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ABSTRACT

Background: Childhood obesity is associated with serious comorbidities during childhood and into adulthood. One potential risk factor for childhood obesity is consumption of unhealthy, energy-dense foods. This scoping review examines evidence on snacking in children aged 2–12 years of age and presents the patterns and position of snacking in children's diets.

Methods: A search of electronic databases (MEDLINE, Web of Science, PubMed, Embase) for articles published from March 2011 to November 2022 was conducted. Articles providing insight into the position of snacking (e.g., energy contribution), or patterns (e.g., location, timing), in children aged 2–12 years were included. A quality assessment was conducted and data was synthesised according to data source (nationally representative or other).

Results: Twenty-one articles were included, most (n = 13) reporting nationally representative data. The average number of daily snacks was 3, with 92.9–100.0% of children consuming snacks. Most were consumed in the afternoon (75.2–84.0%) and at home (46.5–67.3%). Snacks frequently consumed were 'fruits and vegetables', 'baked desserts', 'sweets, candy and confectionery', and 'dairy products'. Snacks contributed 231–565 kcal daily, up to a third of daily carbohydrate intake, a quarter of fat intake, and a fifth of protein intake. Snacks provided up to one third of vitamin C intake, one quarter of vitamin E, potassium and magnesium intake, and a fifth of calcium, folic acid, vitamins D and B12, iron and sodium intake.

Discussion: This scoping review provides insight into patterns and position of snacking within children's diets. Snacking plays a significant role in children's diets with multiple snacking occasions occurring throughout a child's day, the overconsumption of which has the potential to increase risk of childhood obesity. Further research is required into the role of snacking, particularly specific foods playing a role in micronutrient intake, and clear guidance for snacking intake in children.

1. Introduction

Childhood obesity is considered a global public health challenge, which is associated with serious comorbidities that can continue into adulthood, including cardiovascular dysfunction and type 2 diabetes (Bacha & Gidding, 2016; Cote et al., 2013). In 2016, 340 million children and adolescents aged 5–19 years worldwide were considered overweight or obese (World Health Organisation, 2020). Food behaviours and consumption habits can have a significant impact upon diet quality, composition, and overall health and obesity status (Atakan, 2021; Marangoni et al., 2019).

One potential risk factor for childhood obesity is the consumption of unhealthy, energy-dense foods, such as snack and treat foods, during childhood and adolescence (Hess et al., 2016; LeCroy et al., 2019). While there is no clear, standardised definition for 'snack foods', the term often refers to food and beverages consumed in between meals, which could

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be either unhealthy or healthy foods (Hess et al., 2016). In contrast, the term 'treat foods' more often refers to foods high in fat, sugar and salt, consumed either at meal times or in between (Safefood, 2019a). In the literature, there is no consistent definition used for a "snack", and definitions vary from one study to the next, having implications for outcomes, interpretation of results, and application of findings (Gregori et al., 2011a; Hess et al., 2016; Johnson and Anderson, 2010; Murakami and Livingstone, 2016a).

The role of snacking in children's diets is of increasing global concern, with global trends suggesting there has been a significant increase in snacking behaviours over the last number of decades (Duffey, Pereira, & Popkin, 2013; Fayet-Moore et al., 1995; Ford et al., 2013; Roblin, 2007; Wang et al., 2012). There is evidence to suggest that regular overconsumption of unhealthy snack and treat foods in children has the potential to increase risk of childhood obesity, and that limiting consumption of high-fat energy-dense snacks may be associated with a reduction in childhood obesity (Gregori et al., 2011b; Patro and Szajewska, 2010). However, the picture for snacking in general is a little less clear, with some evidence pointing to potential benefits with increased eating frequency throughout the day. While some studies have demonstrated an association between eating frequency and snack frequency with increased energy intake and higher risks of overweight and abdominal obesity in children (Jacquier et al., 2018; Murakami and Livingstone, 2015), others have found higher eating frequencies associated with lower weight status in children and adolescents (Agostoni et al., 2011; Kaisari et al., 2013; Marangoni et al., 2019).

Thus, it is apparent from the existing evidence that snacking significantly influences children's dietary intake. However, it is also clear that the specific patterns of snacking and the position of snacking within children's diets may mediate the impact of snacking occasions upon general health and dietary quality in children (Almoraie et al., 2021). Whether the effects of snacking occasions and increase in eating frequency are harmful or protective rely on the patterns (what snacks, when, where, and how many) and position of snacks (contribution of snacks to overall energy and nutrient intake) within the diet of the child. Whilst a number of individual studies have investigated the role of snacking and snack foods within the diet of children, there is little evidence in the form of reviews. Scoping reviews are a useful tool for compiling available literature, for providing an overview of the evidence and identifying the type of evidence available within an area.

Therefore, this review aims to examine recent evidence on snacking in children aged 2–12 years of age in order to determine the patterns and position of snacking and snack foods in children's diets.

2. Methods

The methodology for this scoping review was guided by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines, following the principles of knowledge synthesis, statement of objectives, selection criteria and synthesis of results (Barello et al., 2020; Moher et al., 2009).

2.1. Search methods

A search of four electronic databases (MEDLINE, Web of Science, PubMed, Embase) was conducted to capture original articles published from March 2011 to November 2022 which addressed the position and patterns of snacking and snack foods within children's diets. The following key words were used: 'child*' or 'young', 'snack*', 'diet*' or 'eat' or 'intake' or 'habit' or 'food*' or 'behaviour*' or 'health' or 'association' or 'relationship' or 'pattern' or 'proportion' or 'frequency' or 'contribution'.

2.2. Study selection

Articles were selected for inclusion in the review if they provided insight into either: i) the position of snacking and snack foods within children's diets (e.g. energy and nutrient intake from snacking and snack foods); or, ii) the patterns of snacking and snack foods in children (e.g. the location, timing, source of snacking and snack foods). Due to the wide range of definitions for snacking and snack foods, articles were not filtered by one chosen definition but, rather, the varying definitions were extracted at the data extraction stage.

Original articles, conducting primary or secondary data analysis, which contained empirical evidence on snacking in children aged 2–12 years, in countries with a 'very high' Human Development Index (HDI), defined as a HDI value higher than 0.8, were included (United Nations, 2020; Safefood, 2019). Where articles had a sample which included the target population of 2–12 year old children, but also ages beyond or below this, these articles were included provided the age groups of interest were stratified (e.g. 6–11 years old and 12–18 years old), or where the mean age of the population fell within the age range (i.e. mean age between 2 and 12 years). Articles which were cross-sectional, cohort or case control studies were included. Review articles, interventional, qualitative studies, and articles not published in English were excluded from the review. As the aim of the review was to gain a broad understanding of the general position and patterns of snacking and snack foods within children's diets, studies conducted in clinical populations were also excluded.

Titles and abstracts were screened by one author in consultation with all authors. Removal of duplicates and title and abstract screening were conducted using Mendeley Reference Manager software. Where there were cases in doubt, a second author advised on the outcome. Articles deemed potentially relevant were then screened according to the full text of the article, and eligible articles were included in the review. Outcomes of interest included quantitative evidence of snacking position and patterns in children aged 2–12 years.

2.3. Data extraction and quality assessment

Data extraction was undertaken using a template developed by authors in Microsoft Excel. Variables extracted included study setting and design, data source, definition of snack or snacking, population size and characteristics, as well as the outcomes related to snacking. Snacking outcomes included frequency, timing and location of snacking as well as common snack foods, and energy and nutrient intake from snacks. Appraisal of the included articles was undertaken using the Quality Assessment Tool for Quantitative Studies developed by the Effective Public Health Practice Project (Visram et al., 2016; EPHPP, 2009). Articles were scored as 'weak', 'moderate', or 'strong' within each sub-component of the tool (selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts). These components were summed to provide an overall rating of 'weak', 'moderate', or 'strong' quality for each article.

2.4. Data synthesis

Where appropriate, if outcomes for the same variable differed in units across studies (for example, energy intake presented as kcal vs kJ), these figures were converted to allow direct comparison of outcomes. Regarding foods or food groups most frequently consumed as snacks, due to the variation (and sometimes large number) of foods and food groups reported, the top three most frequently consumed were selected from each study and recategorised into seven encompassing groups for the purposes of comparison. These categories included: 1) Fruits and vegetables; 2) Dairy products; 3) Sweets, candy and confectionary; 4) Baked desserts and snacks (such as brownies, cookies, biscuits, pies, cakes); 5) Cereal bars and granola; 6) Potato chips; and, 7) Sandwiches.

Articles were first grouped according to the data source and whether it was nationally representative. Data from the included articles have, therefore, been descriptively summarised and narratively synthesised (Visram et al., 2016).

3. Results

After removing duplicates and screening for relevant articles based on title and abstract, and then by full text, a total of 21 original articles met the inclusion criteria and are thus included in the present review (Fig. 1). Study characteristics can be found in Table 1.

3.1. Study characteristics and quality

3.1.1. Country

Almost half (10/21) of the included studies reported data collected from within the United States (Bleich & Wolfson, 2015a; Branscum & Sharma, 2011; Croce, Tripicchio, Coffman, & Fisher, 2022; Deming et al., 2017; Jacquier et al., 2018; Loth et al., 2020; Shriver et al., 2018; Wang et al., 2016, 2018; Xue et al., 2019). A further three studies reported data collected from within Canada (Gilbert et al., 2012; Hutchinson et al., 2018; Vatanparast et al., 2019), and two from within Australia (Rebuli et al., 2020; Wang et al., 2018). One study included data from both the United States and Australia (Wang et al., 2018). The remaining studies were conducted in the United Kingdom (Murakami and Livingstone, 2016b), Spain (Julian et al., 2017), The Netherlands (Gevers et al., 2016), Finland (Eloranta et al., 2011), Japan (Tajima et al., 2021) and New Zealand (Gage et al., 2021).

3.1.2. Data source and population size

Almost two thirds (13/21) of the included studies reported cross-sectional data from nationally representative data sources (Bleich & Wolfson, 2015a; Croce et al., 2022; Deming et al., 2017; Gevers et al., 2016; Gilbert et al., 2012; Jacquier et al., 2018; Julian et al., 2017; Murakami and Livingstone, 2016c; Rebuli et al., 2020; Shriver et al., 2018; Vatanparast et al., 2019; Wang et al., 2016, 2018). For example, the National Health and Nutrition Examination Survey (NHANES) in the United States (Bleich & Wolfson, 2015a), and the National Diet and Nutrition Survey (NDNS) in the United Kingdom (Murakami and Livingstone, 2016c). The remaining studies (8/21) reported data from non-representative sources (Branscum & Sharma, 2011; Eloranta et al., 2011; Gage et al., 2021; Hutchinson et al., 2018; Jensen et al., 2019; Loth et al., 2020; Tajima et al., 2021; Xue et al., 2019), for example, cross-sectional analysis of baseline data from an intervention study (Eloranta et al., 2011).

3.1.3. Population characteristics

3.1.3.1. Age. Among studies that provided a mean age for participants (9/21) (Branscum & Sharma, 2011; Eloranta et al., 2011; Gage et al., 2021; Gevers et al., 2016; Hutchinson et al., 2018; Murakami and Livingstone, 2016c; Vatanparast et al., 2019), the mean age ranged from 2.4 to 12.6 years, with the majority of these studies (6/9) presenting a mean age which fell in the 7–12 years age range (Branscum & Sharma, 2011; Eloranta et al., 2011; Gage et al., 2021; Gevers et al., 2016; Murakami and Livingstone, 2016c). Among the studies which did not provide a mean age for participants, two thirds (8/12) captured a population in the 2–6 years of age range, and a third (4/12) of studies captured a population which spanned the ages of 2 through to 12 years of age.

3.1.3.2. Sex. A small number of studies (3/21) did not provide breakdown of sex. The remaining studies which did provide breakdown of sex had a reasonably equal representation of males and females. One of the smaller, non-representative (n = 52) studies had a split of 56% female.

3.1.3.3. Snack definition. The definition of a snack varied across studies. Just over half of the studies (11/21) used a researcher defined description of a snack, meaning the definition of snack was conferred onto participant's reported intake (Bleich & Wolfson, 2015a; Branscum & Sharma, 2011; Eloranta et al., 2011; Gage et al., 2021; Gevers et al., 2016; Gilbert et al., 2012; Hutchinson et al., 2018; Julian et al., 2017; Murakami and Livingstone, 2016c; Rebuli et al., 2020; Wang et al., 2018). For example, by food group (e.g. "salty snack") (Bleich & Wolfson, 2015a), timing (e.g. "foods consumed between meals") (Wang et al., 2018), or energy intake (e.g. foods contributing less than 15% total energy intake but greater than 210 kJ) (Murakami and Livingstone, 2016c). One study, conducted in Spain, had a culturally-specific definition for snacking, "merienda", described in the study as a "defined eating occasion as mid-afternoon snack (between lunch and dinner)" (Julian et al., 2017) and another, conducted in the United States of America, included a range of Spanish equivalent terms for snacking between meals, including "merienda", but also "bocadillo", "tentempie",

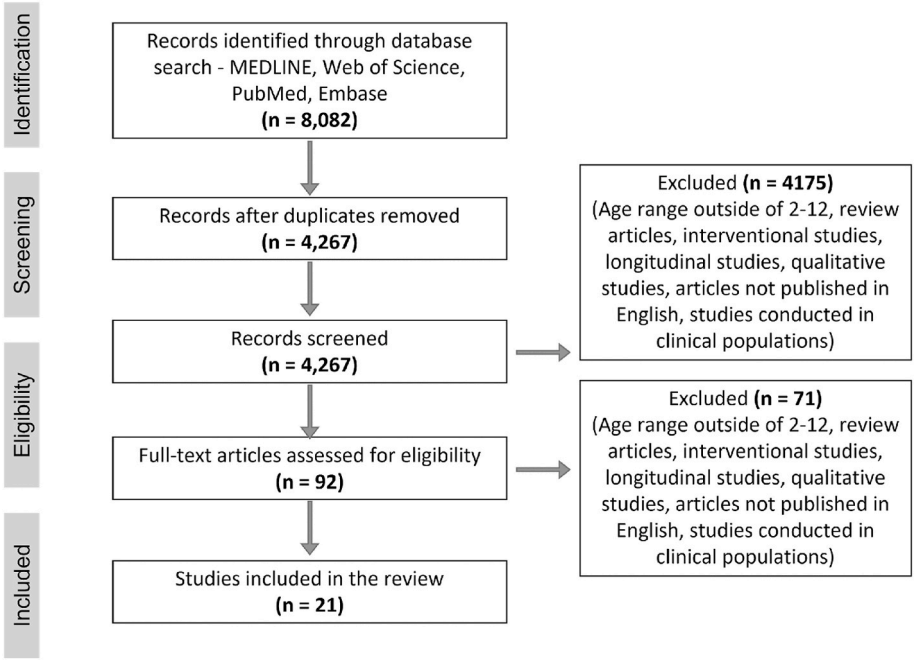

Fig. 1. Flow diagram and selection of studies for review.

Table 1
Characteristics of included studies.

Reference	Country	Study design	Sample size *(*of eligible population)*	Data source	Snacking definition	Age *other age groups included in study	Sex *of full sample	Overall quality score
Nationally representative data sources								
Gilbert et al., 2012	Canada	Cross sectional survey analysis	2495	Canadian Community Health Survey, cycle 2.2 (2004)	Researcher defined: After school (AS) snack intake; i.e., foods consumed Monday to Friday 3–6pm, excluding lunch and dinner	*4–8 years	F: 49% M: 51%	Strong
Bleich & Wolfson, 2015a,b	United States of America	Cross sectional survey analysis	11,142	National Health and Nutrition Examination Survey (NHANES)	Researcher defined: Defined by food group - salty snacks (76items) and sugary snacks (696)	*4879 aged 2–5, 6266 aged 6-11	In both age groups: F: 49% M: 51%	Strong
Gevers et al., 2016	The Netherlands	Cross-sectional survey analysis	860	Dutch National Food Consumption Survey 2007–2010	Researcher defined: Defined using both eating occasion (during/between meals, self-designated by participants), and using a food classification - type of eating occasion taken into account to determine if foods usually consumed as a meal (e.g. pizza) would be counted as snacks	Mean age 9.42 (SD 1.75), range 7–12	F: 49.7% M: 50.3%	Strong
Wang et al., 2016	United States of America	Cross sectional survey analysis	1917	NHANES	Participant defined: Snacking occasions categorised into morn/aft/eve	*Aged 4–8: n = 1917	F: 47.4% M: 52.6%	Strong
Murakami & Livingstone, 2016a,b	United Kingdom	Cross-sectional survey analysis	808	NDNS	Researcher defined: Time-defined/between meals (9–12/2-5/8–6) and contribution to EI (<15% but >210 kJ)	4-10, mean 7.1 (SD 1.9)	F: 46.8% M: 53.2%	Strong
Deming et al., 2017	United States of America	Cross-sectional study analysis	1461	Feeding Infants and Toddlers Study (FITS) 2008	Participant defined	*n = 1461 (in 24–47.9month age range)	Not reported	Strong
Julian et al., 2017	Spain	[Cross-sectional analysis]	2851	Kantar World Panel survey of 4000 households	Researcher defined: Merienda - defined eating occasion as mid-afternoon snack (between lunch and dinner)	3–12 years	F: 49.6% M: 50.4%	Strong
Jacquier et al., 2018	United States of America	Cross-sectional survey analysis	1461	US Feeding Infants and Toddlers Study (FITS) 2008.	Participant defined: Foods/beverages consumed between meals, caregivers were asked to define the type of eating occasion (e.g. breakfast, lunch, dinner or snack)	n = 1461 (in 24–47.9month age range)	F: 43.9–46.4%	Strong
Wang et al., 2018	Australia and United States of America	Cross-sectional survey analysis across 4 national surveys	1646	NHANES (USA) and NNPAS (Aus)	Researcher defined: Foods/beverages consumed between meals (breakfast, brunch[aus], lunch, dinner, supper [USA])	*n = 1646 aged 4–8 in Aus and USA	F: 48% M: 52%	Strong
Shriver et al., 2018	United States of America	Cross sectional survey analysis	3429	NHANES	Participant defined (parent)	2–5 years	/	Strong
Vatanparast et al., 2019	Canada	Cross-sectional survey analysis	2–5 years *n* = 1,181,823 6–12 years n = 2,407,637	Canadian Community Health Survey (CCHS)	Participant defined (by parent or parent/child)	*2–5 years *n* = 1,181,823 6–12 years n = 2,407,637//mean age of 2–18: 9.6 (0.1)	*50.3% male	Strong
Rebuli et al., 2020	Australia	Cross sectional survey analysis	1711	Australian National Nutrition and Physical Activity Survey 2011–2012	Researcher defined: Foods consumed between meals	3.8% aged 2–3; 6.5% aged 4–8; 3.8% aged 9-11	F: 50% M: 50% 2-3: M:49.1% F:50.9% 4-8: M:50.3% F:50.7% 9-11: M:50% F:50%	Strong

(*continued on next page*)

Table 1 (*continued*)

Reference	Country	Study design	Sample size *(*of eligible population)*	Data source	Snacking definition	Age *other age groups included in study	Sex *of full sample	Overall quality score
Croce et al., 2022	United States of America	Cross sectional survey analysis	3313	NHANES	Participant defined: Eating occasions described as "snacks," "beverages", or "extended consumption," as well as the Spanish equivalents of "merienda," "bebida," "bocadillo," "tentempie," and "entre comida" to capture eating in between meals	2–5 years, mean age 3.5	F: 49% M: 51%	Strong
Other data sources								
Branscum & Sharma, 2011	United States of America	Cross-sectional study	166	Original data collection - children recruited in schools	Researcher defined: Foods consumed between meals	Mean age 10.4 (SD = 0.74)	F: 59% M: 41%	Moderate
Eloranta et al., 2011	Finland	Cross-sectional analysis of baseline data in intervention study	424	Baseline data of Physical Activity and Nutrition in Children (PANIC) Study	Researcher defined: Foods/beverages consumed between meals	Mean (SD) age 7.6 (0.4)	F: 49.8% M: 50.2%	Strong
Hutchinson et al., 2018	Canada	Cross-sectional study (baseline data from pilot)	52	Pilot cohort study baseline data	Researcher defined: Foods/beverages (excl. water) consumed between meals	*Mean age 3.4+- (18months-5 yrs)	*F: 56% M: 44%	Moderate
Jensen et al., 2019	Chile	Cross sectional survey analysis	958	Food Environment Chilean Cohort (FECHIC)	Participant defined (counted 'once' as a meal)	4–6 yrs	/	Moderate
Xue et al., 2019	United States of America	Cross-sectional analysis of data from first wave of an ongoing prospective study	417	Data from first wave of ongoing prospective study (Newborn Epigenetic STudy (NEST))	Participant defined (parent/guardian)	2–6 yrs n = 417	*53.9% male	Strong
Loth et al., 2020	United States of America	Cross-sectional data analysis (from phase I of an observational study)	150	Data from phase I of observational study	Participant defined	6–7	F: 47.5% M: 52.5%	Moderate
Gage et al., 2021	New Zealand	Cross-sectional observational study	168	Original data collection - children recruited in schools	Researcher defined: Foods/beverages (excl. water) consumed between meals (main meals 6–10/ 12-3/5–8), but "snacking episodes" also included smaller eating episodes within these times	*Mean age 12.6 (13 year olds also incl. but only made up 15.8%)	*F: 52.5% M: 47.5%	Moderate
Tajima et al., 2021	Japan	Cross-sectional study	378	Multi-regional dietary survey based on nursery schools in Japan	Participant defined (parent/guardian)	3–6 years, mean age 4.5 years (SD 1.1)	F: 50.5% M: 49.5%	Strong

and "entre comida" (Croce et al., 2022). The remaining ten studies used participant defined descriptions of a snack, meaning, at the data collection stage, participants were asked to categorise their foods according to whether they were main meals (e.g. breakfast, lunch, dinner) or snacks (Croce et al., 2022; Deming et al., 2017; Jacquier et al., 2018; Jensen et al., 2019; Loth et al., 2020; Shriver et al., 2018; Tajima et al., 2021; Vatanparast et al., 2019; Wang et al., 2016; Xue et al., 2019).

3.1.4. Quality assessment

Quality ratings for each of the studies can be found in Appendix 1. All studies with nationally representative data source (13/21) (Bleich & Wolfson, 2015b; Deming et al., 2017; Gevers et al., 2016; Gilbert et al., 2012; Jacquier et al., 2018; Julian et al., 2017; Murakami and Livingstone, 2016b; Rebuli et al., 2020; Shriver et al., 2018; Vatanparast et al., 2019; Wang et al., 2016, 2018) were rated overall high quality. In addition, three studies within the non-representative data sources (3/8)[35,46,47] were considered high quality overall. The remaining studies with non-representative data sources (5/8)[34,36,39,48,50] were rated moderate quality; most were rated weak with regards selection bias (small, non-representative populations).

3.2. Patterns of snacking in children

Findings regarding the patterns and position of snacking within children's diets can be found in Table 2 and Table 3, respectively.

3.2.1. Proportion of children consuming snacks

Across studies which provided the percentage of children consuming at least one snack a day (14/21) (Bleich & Wolfson, 2015a; Croce et al., 2022; Deming et al., 2017; Gage et al., 2021; Gilbert et al., 2012; Hutchinson et al., 2018; Jacquier et al., 2018; Jensen et al., 2019; Julian et al., 2017; Shriver et al., 2018; Tajima et al., 2021; Vatanparast et al., 2019; Wang et al., 2016, 2018), the percentage ranged from 92.9% to 100.0%. In addition, a number of studies looked at the proportion of children consuming specific types of snacks or snacks at a specific time of day. From these studies, the mean percentage of children consuming

Table 2
Snacking patterns identified in the included studies.

Reference	Percent (%) consumers	Number of snacks/day	Time of snacking	Snacking location	Most common snacks
Nationally representative data sources					
Gilbert et al. *2012*	63% consumed After School (AS) snacks	/	/	/	Most freq consumed top 3 - fruits (raw, cooked, frozen and canned) (11.6%); water, tea and coffee (11.5%), other beverages (9.9%) [excl water: cookies, biscuits and cereal bars 9.1%]
Bleich and Wolfson, 2015	Aged 2–5: 57.5% salty snack consumers, 71.2% sweet snack consumers Aged 6–11: 59.4% salty snack consumers, 73.9% sweet snack consumers	/	/	Approx. Avg 47 kcal more consumed at home (significant for sweet snacks)	/
Gevers et al. *2016*	/	Mean number of Energy Dense Snack Food (EDSF) events was 3.3/day	•23.0% EDSF events were in the morning, 45.3% in afternoon, 23.0% in evening • 52.6% EDSF events on weekend days, 47.4% on weekdays	49.3% EDSF events were at home, 17.1% at school, 15.2% at a friend's home, 18.4% other (street, sports center, travelling etc.)	Top 3 - cookies (30.9%), sweets (21.2%), potato chips (8.5%)
Wang et al. *2016*	96.6% consumed at least 1 snack	24.0% consumed 1 snack; 46.6% consumed 2; 26.0% consumed 3	Afternoon 79.7%; evening 67.2%; morning 48.3%	/	Morning: water (30.4% consuming), snacks and sweets (18.2%),beverages (9.8%) Afternoon: snacks and sweets (56.7%), beverages (28.1%), water (24.8%) Evening: snacks and sweets (38.3%), water (18.9%), milk and dairy (18.8%)
Murakami and Livingstone, 2016	/	Mean 1.58	/	/	/
Deming et al., 2017	• 24–35.9 month olds: 95.2% • 36–47.9 month olds: 93.7%	• 24–35.9 month olds: 21% had 1, 38% had 2, 31% had 3, 16% had 4+ • 36–47.9 month olds: 22% had 1, 29% has 2, 28% had 3, 15% had 4+	• 24–35.9 month olds: 59.8% morning, 76.4% afternoon, 50.3% evening • 36–47.9 month olds: 57.2% morning, 75.2% afternoon, 60.6% evening	/	• 24–35.9 month olds: Top 3 - fruits (46.3%), cow's milk (38.4%), cookies/cakes/pies (36.8%) • 36–47.9 month olds: Top 3 - fruits (42.9%), cow's milk (40.7%), cookies/cakes/pies (33.1%)
Julian et al. *2017*	84.4% CHILDREN AGED 3–6 and 78.3% aged 7–12 were mid-afternoon snack (merienda) consumers	44/50% consumed 1 food item, 46.5/43.9% consumed 2 food items, 9.5/6% consumed 3 or more	/	/	• Regular younger consumers: fruit (62%); sandwich (59%); biscuits (55%) • Regular older consumers: sandwich (64%); fruit (50%); biscuits (50%)
Jacquier et al. *2018*	Snacks consumed by 95.5% of children	/	/	More consumed at home (67.3%) than away (32.7%)	Sweets were the most popular choice of snack both at home (60%) and away from home (83%)
Wang et al. *2018*	AUS: 99.3% USA: 97.9%	/	/	/	AUS: Water (82.8%); fruits (69.7%), cookies and brownies (42.8%) USA: Water (64.8%); candy (30.4%), fruits (27.6%)
Shriver et al. *2018*	97.50%	/	62% morning, 84% afternoon, and 72% evening	/	/
Vatanparast et al. *2019*	2-5: 96.4% 6-12: 92.9%	2-5: 18% snacked once, 64% 2–3 times, 19% 4 or more times 6-12: 20% snacked once, 61% 2–3 times, 19% 4 or more times	/	/	/
Rebuli et al. *2020*	/	39.8–56.1% total discretionary foods consumed between meals	Afternoon snack occasion contributed 30.6–96.7% towards daily upper limit of discretionary foods	/	Fruit (snacks contributed 50.5–59.3% total fruit intake), discretionary foods (49.7–56.1%) and dairy products (42.6–48.4%)
Croce et al., 2022	98.5% consumed at least 1 snack	Mean was 2.6 daily occasions	/	/	/
Other data sources					
Branscum & Sharma, 2011	/	/	/	/	/
Eloranta et al. *2011*	/	Avg 2.7 snacks daily		/	/
Hutchinson et al. *2018*	96% snacked daily	Mean 2.3 ± 0.7 snacks per day	Most frequently consumed afternoon snacks (82.1% consumed); morning 77.6%; evening 66.7%	/	Most common snacks: crackers, apples, Bear Paws (packaged cookies), yoghurt, granola bars

(*continued on next page*)

Table 2 (*continued*)

Reference	Percent (%) consumers	Number of snacks/day	Time of snacking	Snacking location	Most common snacks
Jensen et al. *2019*	95.2% reported at least 1 snacking event	Avg of 2.30 ± 0.03 snacks per day	/	Larger % of calories from snacks at school (35.5–36.0%) vs home (13.7–16.3%)	Top 3 - Fruits and vegetables (40.0% of participants), grain-based desserts (37.6%), dairy foods (34.8%)
Xue et al. *2019*	/	2.2 times per day	/	/	/
Loth et al. *2020*	/	Avg 1.8 snacking occasions/day	/	/	Fruit (Effect Size: 0.71) and dairy (ES:0.53), refined grains (ES: 0.68) and SSB (ES: 0.31)
Gage et al. *2021*	94.9% consumed at least one snack	Participants consumed avg of 8.2 snacks per 10 h	Most snacks (55.9%) consumed in afternoon [29.7% in morning, 14.0% in evening]	Most consumed at home (47.5%), school (31.7%), public spaces (21.9%)	Top 3 - confectionary (15.5%), snack foods (14.4%), cookies/cakes (12.4%)
Tajima et al. *2021*	100% consumed a snack on weekdays, 92.9% consumed a snack on weekend days	Mean 2.8 (SD 1.2) times per day	/	/	/

after-school snacks was 63% (Gilbert et al., 2012); for mid-afternoon snacks consumption, this ranged from 78.3% to 84.4% (Julian et al., 2017); salty snacks ranged from 57.5% to 59.4% (Bleich & Wolfson, 2015a); and, sweet snacks ranged from 71.2% to 73.9% (Bleich & Wolfson, 2015a).

3.2.2. Frequency of snacking

Among studies which measured number of snacks per day, the pooled mean number of snacks consumed daily was 3. These figures ranged in studies, from 1.6 snacks a day (Murakami and Livingstone, 2016b), to 8.2 snacks a day (Gage et al., 2021). The lowest figure of 1.6 was observed in a representative study, with a mean participant age of 7.1 years, using 24-hr recall (Murakami and Livingstone, 2016b). The high figure of 8.2 snacks a day was observed in a non-representative study, with a mean participant age of 12.6 years, which utilised wearable cameras, and captured snacks consumed at home and in school (Gage et al., 2021). Other studies (3/21) presented percentage of children consuming numbers of snacks (Deming et al., 2017; Vatanparast et al., 2019; Wang et al., 2016). These studies found that children consuming one snack a day ranged from 18% to 24%; for two snacks a day, ranged from 29% to 64%; three snacks a day ranged from 26% to 31%; and four or more snacks a day ranged from 15% to 19%.

3.2.3. Timing of snacking

With regards time of day, all studies reported the afternoon period being the most common period of snack consumption among children. Among the studies which reported the percentage of children consuming snacks according to different times in the day (Deming et al., 2017; Gage et al., 2021; Gevers et al., 2016; Hutchinson et al., 2018; Rebuli et al., 2020; Shriver et al., 2018; Wang et al., 2016), 48.3–77.6% of children consumed a morning snack; 75.2–84% of children consumed an afternoon snack; and, 50.3–72% of children consumed a snack in the evening period. Two studies reported timing of snack consumption with regards the percentage of overall snacks which were consumed at different times (Gage et al., 2021; Gevers et al., 2016). These studies showed that 23.0–29.7% of snacks were consumed in the morning, 45.3–55.9% were consumed in the afternoon, and 14–23% were consumed in the evening. One study (Gevers et al., 2016) also reported that snack consumption was similar on weekdays and weekends, with 52.6% of total snacks consumed on a weekday and 47.4% on a weekend (based on cases with one recall day during the week and one during the weekend).

3.2.4. Location of snacking

A small number of studies looked at the location of snacking (5/21) (Bleich & Wolfson, 2015a; Gage et al., 2021; Gevers et al., 2016; Jacquier et al., 2018; Jensen et al., 2019). Among the studies which presented the percentage of snacking occasions or events according to location (3/5) (Gage et al., 2021; Gevers et al., 2016; Jacquier et al., 2018), 47.5–67.3% of snacks were consumed home, 17.1–31.7% were consumed at school, and 21.9–33.6% were consumed in other locations (such as travelling, sports center, public spaces etc.). Three studies presented the location of snacking according to calories/energy intake consumed from snacks in different locations (Bleich & Wolfson, 2015a; Jacquier et al., 2018; Jensen et al., 2019). One study (Bleich & Wolfson, 2015a) found that more calories were consumed in snacks at home as opposed to snacks consumed outside the home (approximate mean difference of 47 kcal, significant regarding sweet snacks) and another study (Jensen et al., 2019) found that most energy intake from snacks was consumed at home (approx. 46%). However, another (Jacquier et al., 2018) reported that away-from-home snacks provided about an additional 50 calories per day versus snacks consumed at home.

3.2.5. Foods or food groups frequently consumed as snacks

Thirteen studies (13/19) (Deming et al., 2017; Gage et al., 2021; Gevers et al., 2016; Gilbert et al., 2012; Hutchinson et al., 2018; Jacquier et al., 2018; Jensen et al., 2019; Julian et al., 2017; Loth et al., 2020; Rebuli et al., 2020; Tajima et al., 2021; Wang et al., 2016, 2018) provided an indication of foods or food groups most frequently consumed as snacks. As detailed in the methods section, where studies provided frequency tables of foods consumed as snacks, the top three items were selected. From the studies, seven categories of food groups were identified. Among the twelve studies, an equal number (8/13 studies) identified 'fruit and vegetables' and 'baked desserts (including brownies, cookies, biscuits, pies, cakes)' as the most frequently consumed snacks. Sweets, candy and confectionery, and dairy products were identified as frequently consumed snacks by around half of the studies (7/13 and 6/13, respectively). Additionally, a small number of studies also identified cereal bars and granola (2/13), potato chips (1/13), and sandwiches (1/13) as frequently consumed snacks.

3.3. Position of snacking within children's diet

3.3.1. Energy intake from snacks

Two thirds of the studies (14/21) (Bleich & Wolfson, 2015a; Branscum & Sharma, 2011; Deming et al., 2017; Gevers et al., 2016; Gilbert et al., 2012; Hutchinson et al., 2018; Jensen et al., 2019; Loth et al., 2020; Murakami and Livingstone, 2016b; Shriver et al., 2018; Tajima et al., 2021; Wang et al., 2016, 2018; Xue et al., 2019) provided an indication of the daily average calorie intake from snacks. These studies showed that children aged 2–12 years consumed a range of 231–565 kcal from snacks daily. The lowest figure was in a representative study which looked specifically at the consumption of afterschool snacks (Gilbert et al., 2012). The highest figure reported was from a study which analysed multiple representative datasets from different countries, which reported an average of 565 kcal consumed in snacks daily in Australia (Wang et al., 2018). Additionally, a number of studies (13/21) (Bleich & Wolfson, 2015a; Deming et al., 2017; Eloranta et al., 2011; Gilbert et al., 2012; Hutchinson et al., 2018; Jacquier et al., 2018; Jensen

Table 3
Position of snacking within children's diets identified in the included studies.

Reference	Energy intake (kcal) from snacks	Contribution (%) to total energy intake *if calculated by authors	Macronutrient intake	Micronutrient intake	Leading sources of energy/ nutrients
Nationally representative data sources					
Gilbert et al. *2012*	AS snacks provided on Avg 231 kcal*	AS snacks contributed 13%	/	/	AS snacks contributing most energy: Sweet snacks, sugars, candies (mean 120 kJ); Other beverages (117 kJ); Cookies, biscuits and cereal bars (117 kJ)
Bleich and Wolfson, 2015	Aged 2–5: avg 171 kcal from salty snacks, avg 215 kcal from sweet snacks Aged 6–11: avg 230 kcal from salty snacks, avg 321 kcal from sweet snacks	*Aged 2–5: salty snacks 10.7%, sweet snacks 13.5% Aged 6–11: salty snacks 11.6%, sweet snacks 16.1%	/	/	/
Gevers et al. *2016*	Mean 375 kcal*	/	/	/	/
Wang et al. *2016*	Avg 460 kcal: morning 67 kcal; afternoon 241 kcal; evening 152 kcal	25.1%: morning 3.8%; afternoon 13.3%; evening 8.0%	/	/	/
Murakami and Livingstone, 2016	Mean 403 kcal/d*	/	% of energy: Protein:10.5%; fat 35.3%; SFA 15.5%; MUFA 11.2%; PUFA 4.8%; Carbohydrate 54.2%; Starch 22.5%; Total sugar 31.6%; Non-milk extrinsic sugar 23.4%; Dietary fibre 12.3%	/	/
Deming et al., 2017	• 24–35.9 month olds: Mean 307 kcal/d - 91 kcal/d in morning, 137 kcal/d in afternoon, 79 kcal/d in evening • 36–47.9 month olds: Mean 340 kcal/d - 86 kcal/d in morning, 148 kcal/d in afternoon, 106 kcal/d in evening	• 24–35.9 month olds: 24.6% • 36–47.9 month olds: 25.0%	• 24–35.9 month olds: 28.2% carbohydrates, 22.9% fat, 17.2% protein • 36–47.9 month olds: 28.2% carbohydrates, 23.8% fat, 17.7% protein	• 24–35.9 month olds: 27.3% vit C, 24.3% dietary fibre, 18.7% folate, 18.8% vit B12, 23.0% Ca, 20.8% vit D, 24.8% vit E, 18.4% Fe, 22.9% K • 36–47.9 month olds: 25.9% vit C, 25.5% dietary fibre, 18.9% folate, 19.3% vit B12, 23.0% Ca, 21.2% vit D, 24.4% vit E, 18.4% Fe, 22.9% K	/
Julian et al. *2017*	/	/	/	/	/
Jacquier et al. *2018*	/	21–28%	/	/	/
Wang et al. *2018*	AUS: Avg 565 kcal USA: Avg 460 kcal	AUS: 32.9% USA: 26.6%	AUS: Total sugars (kcal) 203; added sugars 99, total fat 73; saturated fat 36; protein 51; fiber (g) 6.3 USA: Total sugars 162; added sugars 103, total fat 146; saturated fat 55; protein 38; fiber (g) 3.1	AUS: Calcium (mg) 250; sodium 495; potassium 718; zinc 1.7; iron 2.1; vitamin C 34.7; vitamin D (μg) N/A; vitamin E as alpha-tocopherol (mg) 2.5 USA: Calcium (mg) 221; sodium 438; potassium 467; zinc 1.5; iron 2.6; vitamin C 22.6; vitamin D (μg) 1.0; vitamin E as alpha-tocopherol (mg) 1.7	/
Shriver et al. *2018*	Mean 451 kcal	28%	Snacks accounted for: 32% total carbohydrates; added sugars 39%; total fat 26.1%; sat fat 27%; dietary fibre 25.7%; 29.1% solid fats	Snacks accounted for: 32.8% vitamin C; iron 20.1%; sodium 19.2%; potassium 26.6%; vitamin A 21.3%; dietary folate equivalents 19.3%	Snacks and sweets food category (i.e., cookies and pastries) were the leading sources of energy (44%), total fat (52%), and added sugars (53%) consumed during snacking occasions
Vatanparast et al. *2019*	/	2-5: 27.0% 6-12: 26.5%	Contribution of snacks 2-5: Carbohydrates 29.9%; dietary fibres 30.4%; total sugars 37%; total fat 27.2%; SFA 26.8%; MUFA 26.6%; PUFA 27.8%; protein 19.6% 6-12: Carbohydrates 29.8%; dietary fibres 29.6%; total sugars 35.8%; total fat 26.4%; SFA 25.9%; MUFA 25.8%; PUFA 26.7%; protein 17.0%	2-5/6–12: Vitamin A RAE (%) 20.0/20.0; Vitamin D (%) 17.7/16.9; Vitamin C (%) 30.2/29.7; Thiamin (%) 20.4/19.2; Riboflavin (%) 24.3/21.2; Niacin NEA (%) 18.7/16.8; Vitamin B6 (%) 22.6/20.8; Vitamin B12 (%) 18.4/16.1; Folic acid (%) 20.3/19.2; Folate DFE (%) 21.4/20.7; Calcium (%) 26.3/23.3; Magnesium (%) 24.9/23.9; Iron	/

(*continued on next page*)

Table 3 (*continued*)

Reference	Energy intake (kcal) from snacks	Contribution (%) to total energy intake *if calculated by authors	Macronutrient intake	Micronutrient intake	Leading sources of energy/ nutrients
				(%) 21.9/21.3; Zinc (%) 20.5/ 18.4; Sodium (%) 18.6/18.1; Potassium (%) 25.7/24.5	
Rebuli et al. *2020*	/	/	/	/	/
Croce et al., 2022	Mean 168 kcal/ occasion	26.9%	/	/	/
Other data sources					
Branscum & Sharma, 2011	302.3 kcal (SD 265.11) from calorically dense snack foods	N/A	/	/	Energy: fried potato or corn chips, cookies, and candies
Eloranta et al. *2011*	/	41.8% (41.3% in boys, 42.3% in girls)	Proportion of total fat from TEI from snacks: 28.5% (boys) and 28.2% (girls); SFA: 12.4%/12.3%, MUFA: 8.9%/8.8, PUFA: 4.3% both, sucrose 20.1%/20.2%, fibre g/MJ 2.1% both	/	/
Hutchinson et al. *2018*	Avg 468 kcal	33.20%	Avg snack composition: protein 12.4g (11.1% energy from protein in snacks); carbohydrate 73.8g (62.3% energy from carbohydrate in snacks); sugar 44.0g (37.2%)/ 59.2% of carbohydrate from sugar; fibre 5.8g; fat 14.8g/133.5 kcal (28.9%); sat fat 6.1g; *trans*-fat 0.3g	Sodium 390 mg	/
Jensen et al. *2019*	Avg 360 kcal daily	28.90%	% of total intake: protein 20.0%, total carbohydrates 32.8%, fibre 28.7%, total sugars 41.7%, total fat 26.4%, sat fat 28.6%	% of total intake: 24.7% sodium	/
Xue et al. *2019*	Mean 387 kcal/day	Approx. 25%	% total fat from snack 23%; total carbohydrate 28%; total protein 16%; total sugar 32%	/	/
Loth et al. *2020*	Approx 365 kcal/day	/	/	/	/
Gage et al. *2021*	/	/	/	/	/
Tajima et al. *2021*	Mean 267.3/day (SD 106.6)	Mean 19.5% (SD 6.9)	Contribution (%) of snacks: protein 14.9%, total fat 20.4%, carbohydrate 20.8%, SFA 28.1%, free sugar 46.2%, fibre 13.2%	Contributon (%) of snacks: Na 8.8%, K 20.3%, vit A 17.2%, thiamine 15.5%, riboflavin 25.4%, niacin 11.4%, vit B6 13.6%, vit B12 12.8%, folate 13.2%, vit C 15.9%, calcium 34.8%, iron 12.6%, zinc 15.3%, copper 13.8%	Confectionaries (35.3% EI) and milk (19.5% EI)

et al., 2019; Loth et al., 2020; Shriver et al., 2018; Vatanparast et al., 2019; Wang et al., 2016, 2018; Xue et al., 2019) provided energy intake from snacks in terms of percentage of total energy intake. Contribution of snacks to total energy intake ranged from 12.9% to 41.8%. The former, again, was from the study reported only on after-school snacks (Gilbert et al., 2012), and the latter was a relatively smaller study (n = 424), conducted in a non-representative population (Eloranta et al., 2011).

3.3.2. *Macronutrient intake from snacks*

Ten studies overall provided some insight into macronutrient intake from snacks (Deming et al., 2017; Eloranta et al., 2011; Hutchinson et al., 2018; Jensen et al., 2019; Murakami and Livingstone, 2016b; Shriver et al., 2018; Tajima et al., 2021; Vatanparast et al., 2019; Wang et al., 2018; Xue et al., 2019). The reporting of this varied in outcomes across studies, as did the specific macronutrients included in the analysis, with some studies reporting nutrient intake in more detail. Six studies measured nutrient intake with regards to percentage intake of nutrients which was coming from snacks, as opposed to other eating occasions, such as meals. These studies showed that snacks provided a range of 20.8–32.8% intake of carbohydrates (32–41.7% total sugar, 35.7% added sugars), 20.4–26.8% intake of total fats (23.9–28.6% Saturated Fatty Acids (SFA), 26.2% Monounsaturated Fatty Acids (MUFA), 27.3% Polyunsaturated Fatty Acids ((PUFA)), and 14.9–20% intake of protein.

A further four studies measured nutrient intake with regards compositional breakdown of snack, either in terms of: i) energy composition, with each nutrient presented as a percentage of energy; ii) energy composition, with each nutrient presented according to kcal contribution; or, iii) contribution of nutrients in grams (g). According to one study, snacks comprised of an average 73.8g of carbohydrates (44.0g total sugar), 14.8g of total fats (6.1g SFA, 0.3g TFA), and 12.4g of protein. According to another study analysing two datasets, snacks comprised 162–203 kcal total sugar, 99–103 kcal added sugars, 73–146 kcal total fats, 36–55 kcal SFA, 38–51 kcal protein. Fibre was reported in two studies, and snacks comprised 3.1–6.3g of fibre (Hutchinson et al., 2018; Wang et al., 2018). Average breakdown of snacks according to macronutrient makeup, according to two studies, ranged between 54.2 and 62.3% carbohydrate (31.6% total sugar, 20.2% sucrose, 12.3% fibre), 28.4–35.3% total fats (12.4–15.5% SFA, 8.9–11.2% MUFA, 4.3–4.8% PUFA), and 10.5–11.1% protein.

3.3.3. *Micronutrient intake from snacks*

Only seven studies reported micronutrient intake from snacks (Deming et al., 2017; Hutchinson et al., 2018; Jensen et al., 2019; Shriver et al., 2018; Vatanparast et al., 2019; Wang et al., 2018).

Similarly to macronutrient intake, this varied in how intake was reported, and the number of nutrients analysed (e.g. two studies (Jensen, Hutchinson) reported only sodium intake). Two studies reported average composition of snacks (with regards mg/μg intake). These studies report an average intake of 28.7 mg vitamin C, 235.5 mg calcium, 1.0 μg vitamin, 2.1 mg vitamin E, 2.4 mg iron, 593.0 mg potassium, 1.6 mg zinc, and 390–466.5 mg sodium.

The remaining four reported percentage of nutrient intake which was coming from snacks, as opposed to other eating occasions. Snacks contributed between 15.9% and 32.8% of vitamin C intake, 18.8–19.8% of folic acid intake, 12.8–19.1% of vitamin B12 intake, 21.1–34.8% of calcium intake, 17.3–21% of vitamin D intake, 24.6% of vitamin E intake, 12.6–21.6% of iron intake, 20.3–26.6% of potassium intake, 15.3–19.5% of zinc intake, 8.8–19.2% of sodium intake, 15.5–19.8% of thiamin intake, 22.8–25.4% of riboflavin intake, 11.4–17.8% of niacin intake, 13.6–21.7% of vitamin B6 intake, 24.4% of magnesium intake, and 17.2–21.3% of vitamin A intake.

4. Discussion

The aim of this review was to examine recent evidence on snacking in children aged 2–12 years, in order to determine the patterns and position of snacking and snack foods in children's diets. The resulting evidence from 21 studies of high (n = 14) or moderate (n = 7) quality, suggests that snacking plays a substantial role in the daily dietary intake of children aged 2–12 years with 92.9%–100% of children consuming at least one snack a day, with an average of 3 snacks throughout the day. More snacks, on average, are consumed in the home, and in the afternoon period. Among the most common snacks consumed by children, as reported by the studies, included: 'fruits and vegetables'; 'baked desserts'; 'sweets, candy and confectionary'; and, 'dairy products'. Snacks contributed 231–565 kcal daily; contributed up to a third of daily carbohydrate intake, a quarter of total fat intake, and just under a fifth of protein intake. In addition, snacks provided up to one third of vitamin C intake, one quarter of vitamin E, potassium and magnesium intake, and a fifth of calcium, folic acid, vitamins D and B12, iron and sodium.

Snack consumption among children is generally very high, with an average 92.9%–100% of children consuming at least one snack a day. The pooled average number of snacks per day across the studies was 3 snacks. It is difficult to contextualise this within recommended snacking-specific guidelines, given the number of different countries captured in this review, and given that countries and organisations differ in their recommendations (Marangoni et al., 2019; Potter et al., 2018). However, in a recent review of global snacking recommendations, most countries' (n = 47) guidelines (which included quantitative recommendations) recommended an intake of 2–3 snacks per day (Potter et al., 2018). This suggests that the average number of snacks consumed across the studies is well within recommended levels. However, a number of studies in the review also captured children who consumed four or more snacks each day (Deming et al., 2017; Vatanparast et al., 2019) and one study reported that participants consumed an average of 8.2 snacks in a 10hr period (Gage et al., 2021). The latter study was comparatively small (n = 158); however, data was collected using wearable cameras which captured images of food consumed. This could potentially suggest discrepancies between reporting of snacks using food frequency questionnaires and dietary recall, and the objective number of snacks consumed in children.

Reflecting previously described existing trends in the literature (Hess et al., 2016; Potter et al., 2018), the definitions used for "snack" varied across the studies. Just over half of the studies used a 'researcher-defined' description of a snack, meaning researchers inferred, by food group, timing or energy intake, the consumption of a snack as reported by participants. As prior studies have suggested (Gregori et al., 2011a; Johnson and Anderson, 2010; Murakami and Livingstone, 2016b), this inconsistency in defining the term had implications for comparisons of study design, data collection and outcome variability across studies in the present review. The definition of snack and the study design chosen in each study to investigate it, had implications for all outcomes of interest in this review. For example, when comparing the 'foods or food groups most frequently consumed as snacks', one must consider the definition and study design of each study. One study which investigated only energy-dense snack foods (Gevers et al., 2016), found the most frequently consumed snacks to be cookies, sweets and potato chips. Whereas a study which investigated snacks as a whole (including conventionally "healthier" snacks) (Jensen et al., 2019) found the most frequently consumed snacks to be fruits and vegetables, grain-based desserts and dairy foods.

Another influence upon chosen definition of snack is that of cultural differences within and between countries. This is demonstrated by one study (Julian et al., 2017) which used a culturally-specific definition of a "merienda" defined in the study as a "defined eating occasion as mid-afternoon snack (between lunch and dinner)". Under this definition, sandwiches were identified in the study as being a commonly consumed snack (Julian et al., 2017), with no other studies identifying sandwiches as a frequently consumed snack. This reflects the potential for cultural differences to impact definition of snacking, and indeed, what children consume as snacks (Damen et al., 2019; Fjellström, 2004; Gibson et al., 2020; Marangoni et al., 2019).

Differences in snacking culture across countries can also be observed when looking at intake from snacks. Snacks provided 231–565 kcal daily, and snacks contributed between 12.9% and 41.8% of total daily energy intake. The higher end of this range may because for concern, given that consumption of unhealthy, energy-dense snacks can potentially increase risk of childhood obesity (Hess et al., 2016; LeCroy et al., 2019). The majority of global guidelines and recommendations which have provided guidance on suggested energy intake from snacks have done so per snacking occasion (i.e., 5–15% of daily energy intake), rather than overall intake. Thus it is hard to state whether these findings fall within a recommended range (Potter et al., 2018). However, it is worth highlighting the article which reported the highest caloric intake from snacks; a study which found that Australian children consumed, on average, 565 kcal from snacks (Wang et al., 2018). This is much higher when compared to other studies with nationally representative data, for example, one in The Netherlands with an older child population, which reported a mean of 375 kcal from snacks (Gevers et al., 2016). This finding potentially adds to the belief that culture plays an important role in determining the snacking patterns and position of snacks within children's diets, from one country to another, and indeed within countries (Damen et al., 2019; Fjellström, 2004; Gibson et al., 2020; Marangoni et al., 2019). In addition, ethnicity was explored by a number of studies in the review which found that ethnicity played a significant factor in consumption of calorically dense snack foods (Branscum & Sharma, 2011), and in snacking location (Jacquier et al., 2018).

With regards to location of snacking, the small number of studies which reported location all identified that a higher percentage of snacking occasions were consumed at home. However, two studies found that at-home snacks provided more energy (Bleich & Wolfson, 2015b; Jensen et al., 2019), and one study reported that away-from-home snacks provided more energy (Jacquier et al., 2018). One factor that may be influencing this disagreement is that of age; with the studies reporting higher energy snacks at-home looking at children aged 2–11 and 4–6 years, respectively, and the study reporting higher energy snacks away-from-home looking at pre-school aged children (24–47.9 months). Further factors are that of the role that parents and caregivers in children's eating behaviours, and also children's involvement in the selection and preparation of the food, something not within the remit of this review, but important factors of note recognised in previous snacking literature (Allirot, Maiz, & Urdaneta, 2018; Blaine, Kachurak, Davison, Klabunde, & Fisher, 2017; Johnson et al., 2020; Lavelle et al., 2016).

The studies in the present review highlighted that snacks are most commonly consumed in the afternoon time, compared to any other time

of day. The majority of snack consumption taking place in the afternoon may be considered a positive finding from the review; as there is evidence to suggest afternoon snacks may play an important role in the control of appetite and eating behaviours, with a number of studies highlighting positive effects of afternoon snacks, particularly nutrient-dense snacks, including satiety, appetite control and diet quality (Leidy et al., 2015; Mahoney et al., 2007; Marangoni et al., 2019). The location of snacking may also have played a role in determining the timing, for example, a high consumption of snacks may be because it is a common time for after-school snacks in children. The high consumption of afternoon snacks is a trend identified in populations beyond those included in this review; for example, in countries that do not have a "very high HDI" (Cezimbra et al., 2021) and young adults (Mahoney et al., 2007).

Snacks contributed up to a third of carbohydrate intake, a quarter of total fats and a fifth of protein. There exists very little guidance on the acceptable or advisable nutrient intake for snacks in children, however, Denmark is one country which advises that snacks in adults should contribute no more than 30% total fat and no more than 10% saturated fat energy (DTU National Food Institute, 2012; Potter et al., 2018). This may suggest that the average contribution of snacks to saturated fat intake (26.5%) is higher than acceptable levels in children, particularly when considering that high-fat, energy-dense snacks may be a risk factor for childhood obesity (Gregori et al., 2011b; Patro and Szajewska, 2010). However, this is perhaps unsurprising due to the popularity of dairy products and treat foods as snacks. It is difficult to comment on micronutrient intake from snacking, due to the limited number of studies which reported these findings. However, it is clear, from the small number of studies which did report micronutrient intake, that snacking has the potential to contribute substantially to nutrient intake (e.g., contributing up to a third of overall vitamin C intake). There is a need for further investigation of larger, representative datasets which could provide greater insight into the micronutrient breakdown of snacks consumed by children.

4.1. Limitations

Similar to existing research, the lack of consistency in defining snacks poses difficulties in comparison of findings. The heterogeneity of the studies (i.e., variation in definition, outcomes, and quality of the studies) mean that the pooled averages and summations, particularly regarding nutrient intake, suggest a need for caution in the interpretation of results. In addition, a number of studies (8/21) were conducted among a non-representative, and in some cases small (e.g., n = 52 (Hutchinson et al., 2018)) populations. Heterogeneity continues as a pattern in the review when considering the different datasets and data sources, using, in some cases, different data collection methods, and as a result, food or food groups most frequently consumed may differ or overlap according to variation in defined food categories. For example, one study (Rebuli et al., 2020) recorded "dairy products" as a frequently consumed snack, and another study (Deming et al., 2017) recorded "cow's milk" as a frequently consumed snack. In this case, the food reported in one study may be included under a broad categorization into a food group recorded in another study. Further limitations of this study include a single author was responsible for extracting data from the included articles, which has the potential to introduce bias, and the exclusion of interventional and qualitative studies which may provide further insight into the available evidence. Finally, only studies conducted within countries with "very high HDI" were collated for this review, which limits application of findings in the wider global context.

5. Conclusion

This review provides insight into the patterns and position of snacking within children's diets. The studies captured in the review ranged in their definitions of snacks, however, it is clear that snacking plays a significant role in the diets of children aged 2–12 years of age. Multiple snacking occasions occur throughout a child's day. Snacks are most commonly consumed in the home, in the afternoon and account for approximately one quarter of energy intake in children. Cultural differences may play a role in determining the patterns of snacking and position of snacking within children's diets. Snacks contribute up to a third of vitamin C intake, but are potentially high in saturated fats, providing over a quarter of all saturated fat intake. This may be of particular concern, given the potential association between consumption of high-fat energy-dense snacks and childhood obesity. Further research is required into consistent definitions for snacking, and the role of snacking in children's diets, particularly the specific foods which play a role in micronutrient intake, and clear guidance for snacking intake in children.

8. Author contributions

NOK designed the methodology, conducted the scoping review and prepared the first manuscript draft. AN, SW, LK, EOS and AM all provided input into the methodology and data synthesis. JW, JW and AN were responsible for conceiving the project and acquiring funding. All authors provided critical feedback and have approved the final article.

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Ethical statement

The enclosed manuscript is a scoping review, which involved conducting a review of published literature. There was no human involvement in our research study, and therefore, no ethical approval was required from our institutions or funders.

Declaration of competing interest

None.

Data availability

No data was used for the research described in the article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.106974.

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