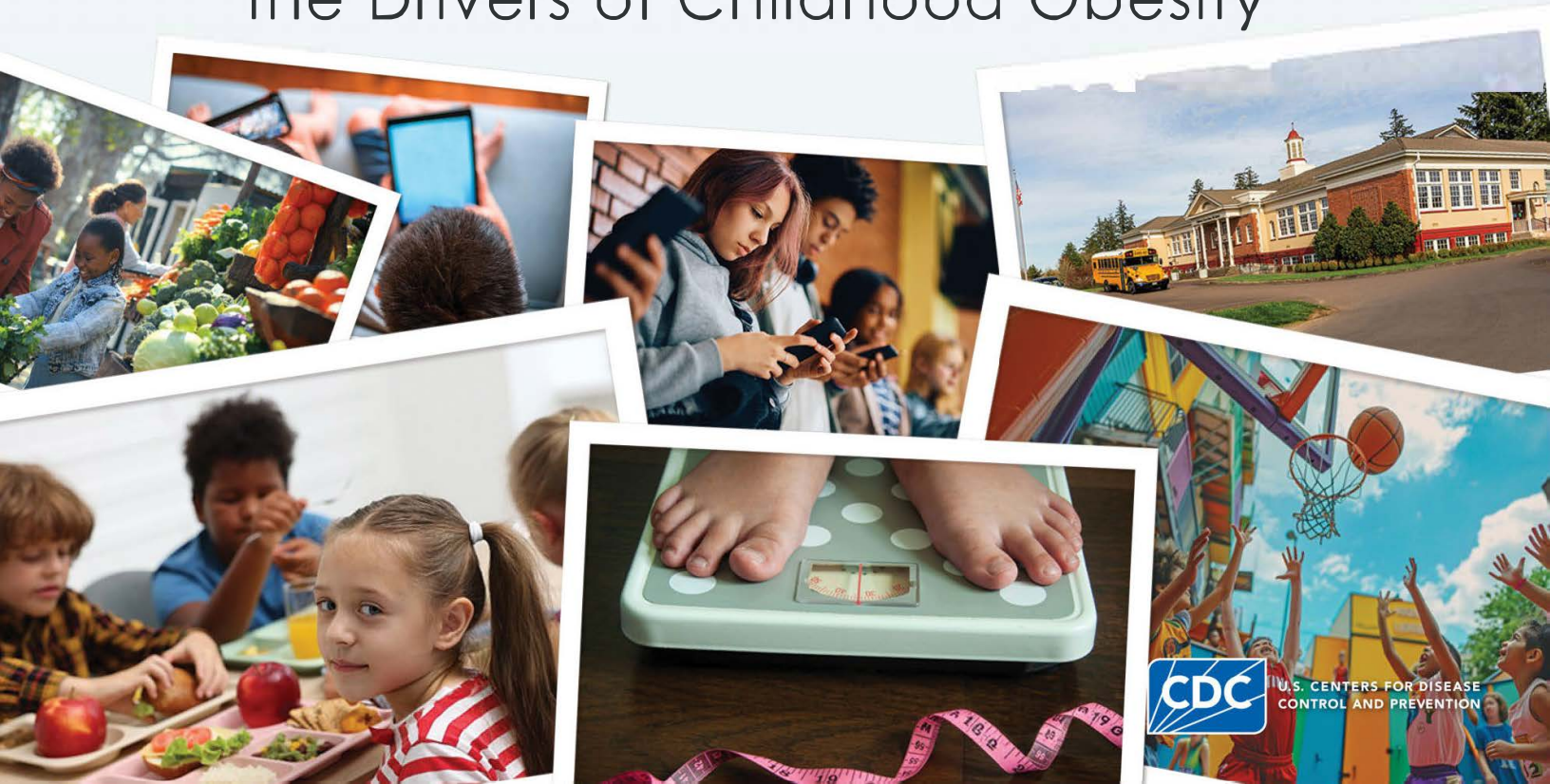


PREVENTING CHRONIC DISEASE
PUBLIC HEALTH RESEARCH, PRACTICE, AND POLICY

BEYOND THE PLATE

Understanding and Addressing the Drivers of Childhood Obesity



CDC
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A Word From the Editor in Chief

Childhood obesity is shaped by more than individual food choices. Children's diets are influenced by the broader food environment, including the availability of ultra-processed foods, specifically high-sodium and sugar-sweetened products, and their social acceptance as a result of their prominence in the media. These factors are interconnected with the availability of healthy foods, access to safe places for play, physical activity, sleep, and screen time. Together, they make childhood obesity a complex public health issue shaped by families, communities, schools, media, and the built environment.



Addressing childhood obesity requires coordinated, evidence-based action beyond individual choices. The 8 peer-reviewed articles in this collection examine how families, caregivers, schools, communities, and public health professionals can create healthier environments and routines for children. Their findings address food and beverage choices, physical activity, ultra-processed foods, screen time, stress, and increase access to healthy food options, offering practical strategies to support the growth and well being for every child.

Leonard Jack, Jr, PhD, MSc
Editor in Chief, Preventing Chronic Disease

About the Journal

Preventing Chronic Disease (PCD) is a peer-reviewed public health journal sponsored by the Centers for Disease Control and Prevention and authored by experts worldwide. PCD was established in 2004 by the National Center for Chronic Disease Prevention and Health Promotion with a mission to promote dialogue among researchers, practitioners, and policy makers worldwide on the integration and application of research findings and practical experience to improve population health.

PCD's vision is to serve as an influential journal in the dissemination of proven and promising peer-reviewed public health findings, innovations, and practices with editorial content respected for its integrity adrelevance to chronic disease prevention.

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RESEARCH BRIEF

Top Food Contributors of Sodium Intake in US Children and Adults Aged 1 Year or Older, National Health and Nutrition Examination Survey, August 2021–August 2023

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PEER REVIEWED

Summary

What is already known on this topic?

Dietary sodium intake exceeds recommended daily levels for most children and adults in the US.

What is added by this report?

Overall, the 8 largest contributors to sodium intake were deli meat sandwiches, pizza, savory snacks, soups, poultry, pasta mixed dishes, bread, and cheese. Results were mostly consistent across subgroups of sex, hypertension status, and overweight/obesity, with differences among young children and some racial and ethnic groups.

What are the implications for public health practice?

Consumers, food manufacturers, policymakers, and others can focus on the largest contributors of sodium intake to inform interventions aimed at reducing excess sodium intake and the consequent risk of adverse health outcomes.

Abstract

To identify the food categories contributing most to sodium intake in the US, we used 2021–2023 National Health and Nutrition Examination Survey data. Approximately one-third of total dietary sodium intake among children and adults came from deli meat sandwiches (5.0%), pizza (4.4%), savory snacks (4.4%), soups (4.4%), poultry (3.8%), pasta mixed dishes (3.8%), bread (3.1%), and cheese (2.7%). Among subgroups, the highest contributor to sodium intake among children aged 1 to 11 years was savory snacks (approximately 8%) and among non-Hispanic Asian participants, soups (8.7%). Information on current top contributors to sodium intake can be leveraged to inform sodium reduction interventions.

Introduction

Excess sodium intake throughout the lifespan is associated with adverse health outcomes, including hypertension and cardiovascular disease later in life (1). Among children and adults combined (aged ≥1 y), 89% exceed recommended daily maximum intake levels of sodium (aged 1–3 y = 1,200 mg/day; 4–8 y = 1,500 mg/day; 9–13 y = 1,800 mg/day; ≥14 y = 2,300 mg/day) (2). Effective systems-level and behavioral interventions could promote reductions in daily sodium intake. Identifying the top food contributors to sodium intake can help inform these interventions.

The most recently published studies using data from the 2015–2016 (3) and 2017–2018 (4) National Health and Nutrition Examination Survey (NHANES) reported several food categories as the consistent top contributors to sodium intake overall among both children and adults, including bread, cold cuts, pizza, poultry, soups, and savory snacks. Our study aimed to update previous evidence to identify the food categories contributing most to sodium intake among US children and adults, overall and by demographic subgroups. Updated food categories in the most recent NHANES data allow more detailed categorization for several key food groups (eg, sandwiches, soups).

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Methods

Study sample

We used data from the August 2021–August 2023 NHANES, a nationally representative survey of the noninstitutionalized US civilian population conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics (5). Interviewers obtained written informed consent from adults or consent from a parent or guardian for participants younger than 18 years. This analysis was conducted in accordance with applicable federal law and was not subject to institutional review board approval because data used were deidentified.

Statistical analysis

Demographic variables were age (1–4 y, 5–11 y, 12–17 y, 18–39 y, 40–59 y, ≥60 y), sex (female, male), race and ethnicity (Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, non-Hispanic Other [American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, and "other"]). Overweight or obesity was based on body mass index (≥85th percentile for those aged 2–19 y and ≥25 kg/m^2 for those aged ≥20 y). Hypertension (self-reported use of hypertension medication, measured systolic pressure ≥130 mm Hg, or measured diastolic pressure ≥80 mm Hg) was measured for participants aged 18 years or older.

To estimate sodium intake, we used the first of two 24-hour dietary recalls recorded using the US Department of Agriculture's (USDA's) automated multiple-pass method (6). We categorized foods into 90 mutually exclusive categories adapted from USDA's What We Eat in America (2021–2023) (7). The proportion of each food category contributing to daily sodium intake was defined as the sum of the sodium consumed from a given food category for all participants in the designated group divided by the sum of the sodium consumed from all food categories for all participants in the same group. Sodium included salt added during food preparation but not salt added at the table. Sodium density was calculated as milligrams of sodium per 1,000 kcal. We used R version 4.5.0 (R Foundation) for analyses, accounting for the complex survey design and estimating variance using Taylor series linearization. Survey weights from day 1 dietary recall were used.

Results

Among 8,860 participants, 2,227 were excluded: 133 (1.5%) were younger than 1 year; 2,113 (23.8%) did not have a valid dietary recall or reported zero calories of intake; and 60 (0.7%) reported consuming human milk, resulting in an analytic sample of 6,633 participants.

Overall, mean (SE) daily sodium intake was 3,103 (30) mg and was highest for adults aged 18 to 39 years, males, and non-Hispanic Asian adults (Figure 1 and Figure 2).

Overall rank	Food category	Proportion of sodium intake								
			Age, y						Sex	
		Overall	1–4	5–11	12–17	18–39	40–59	≥60	Female	Male
Top 25 contributors to sodium intake overall										
1	Deli meat sandwiches	5.0	1.9	4.1	5.7	4.7	5.8	5.0	4.8	5.2
2	Pizza	4.4	5.1	6.6	6.0	4.7	4.3	2.8	4.0	4.8
3	Savory snacks (eg, chips, crackers, popcorn)	4.4	7.7	8.3	5.7	3.7	3.8	4.1	5.0	4.0
4	Soups	4.4	3.7	3.7	4.4	4.1	4.5	4.9	4.8	4.0
5	Poultry (excluding nuggets and tenders)	3.8	2.0	3.2	2.6	4.7	3.6	3.4	3.3	4.2
6	Pasta mixed dishes, excludes macaroni and cheese	3.8	4.0	3.2	4.5	4.3	3.7	3.1	3.8	3.7
7	Breads, rolls and buns	3.1	2.3	2.4	3.3	2.6	3.2	3.8	3.3	2.8
8	Cheese (including cottage cheese and ricotta)	2.7	3.6	3.1	2.2	2.6	2.5	3.1	3.1	2.4
9	Vegetables (excluding white potatoes)	2.4	1.8	1.6	1.1	2.1	2.4	3.5	2.8	2.0
10	Burritos and tacos	2.4	0.8	1.8	3.1	3.1	2.2	1.6	2.0	2.6
11	Cookies, brownies, cakes	2.4	2.5	2.9	2.5	1.8	2.1	3.2	2.5	2.2
12	Burgers	2.4	0.8	2.5	2.7	2.6	2.5	1.8	1.9	2.7
13	Meat mixed dishes	2.3	1.3	0.7	1.2	2.0	2.6	3.6	2.2	2.4
14	Tomato-based condiments	2.3	2.3	2.4	2.0	2.7	2.2	1.8	2.1	2.5
15	Poultry mixed dishes	2.3	2.1	1.1	1.5	2.3	3.1	2.0	2.3	2.3
16	Eggs and omelets	2.1	2.3	1.3	1.4	2.2	2.1	2.6	2.2	2.0
17	Egg sandwiches	2.0	0.4	1.2	2.0	2.0	2.0	2.1	1.6	2.3
18	Cold cuts and cured meats (excluding sandwiches)	1.9	4.8	1.7	0.9	2.0	1.9	1.9	1.8	2.0
19	Chicken nuggets and tenders	1.9	5.3	4.0	3.6	2.1	0.9	0.9	1.9	1.9
20	Bacon, frankfurters, sausages (excluding sandwiches)	1.8	3.2	2.2	1.4	1.6	1.7	2.2	1.8	1.9
21	Rice	1.8	2.1	2.2	2.1	1.9	2.1	1.0	1.5	2.0
22	Mashed, baked, or boiled white potatoes	1.6	0.4	0.6	1.6	1.5	1.4	2.6	1.7	1.6
23	Salad dressings and vegetable oils	1.6	0.6	0.8	1.0	1.6	1.5	2.1	1.8	1.4
24	Fried white potatoes	1.5	1.5	1.4	1.4	1.5	1.6	1.4	1.4	1.6
25	Dips, gravies, other sauces	1.5	3.0	0.8	1.2	1.7	1.7	1.0	1.8	1.2
Among the top 10 contributors to sodium intake within a subgroup (not a top 25 contributor overall)										
29	Ready-to-eat cereals	1.3	1.9	2.5	2.6	0.9	0.9	1.4	1.4	1.4
34	Milk, unflavored	1.1	4.6	2.0	1.7	0.6	0.9	1.2	1.3	1.1
38	Pancakes, waffles, French toast	1.0	2.8	2.9	1.5	0.7	0.5	0.8	0.8	1.3
Sodium intake										
Daily sodium intake, mean (SE), mg		3,103 (30)	2,071 (75)	2,637 (50)	3,110 (107)	3,417 (66)	3,285 (52)	2,874 (41)	2,698 (36)	3,521 (40)
Daily sodium density intake, mean (SE), mg/1,000 kcal		1587 (10)	1,402 (27)	1,451 (15)	1,552 (23)	1,676 (10)	1,612 (24)	1,547 (15)	1,573 (18)	1,601 (10)

% of sodium intake	0–0.9	1.0–1.9	2.0–2.9	3.0–3.9	4.0–4.9	≥5.0

Figure 1. Top food category contributors to sodium intake among those aged 1 year or older, by age and sex, National Health and Nutrition Examination Survey, August 2021–August 2023. Gray shading indicates a relative SE ≥0.30; estimate is therefore statistically unreliable.

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Overall rank	Food category	Proportion of sodium intake									
			Race and ethnicity					Overweight or obesity		Hypertension	
		Overall	Hispanic	Non-Hispanic Asian	Non-Hispanic Black	Non-Hispanic White	Non-Hispanic Other	No	Yes	No	Yes
1	Deli meat sandwiches	5.0	4.9	1.3	3.9	5.7	4.0	4.6	5.3	4.6	5.7
2	Pizza	4.4	3.9	4.2	5.7	4.4	4.1	4.8	4.3	3.8	4.3
3	Savory snacks (eg, chips, crackers, popcorn)	4.4	3.3	3.0	4.3	4.9	5.1	5.1	4.1	3.9	3.9
4	Soups	4.4	5.5	8.7	4.6	3.6	3.8	4.6	4.2	4.5	4.3
5	Poultry (excluding nuggets and tenders)	3.8	4.2	3.6	7.3	3.0	4.1	3.8	3.8	4.3	3.7
6	Pasta mixed dishes, excludes macaroni and cheese	3.8	2.7	4.1	3.7	4.1	3.9	4.1	3.6	4.1	3.5
7	Breads, rolls, and buns	3.1	2.4	4.0	2.5	3.3	2.9	3.2	3.0	2.9	3.3
8	Cheese (including cottage cheese and ricotta)	2.7	2.1	1.1	1.5	3.2	3.1	2.4	2.9	2.6	2.8
9	Vegetables (excluding white potatoes)	2.4	1.8	3.5	2.6	2.4	1.9	2.5	2.3	2.5	2.7
10	Burritos and tacos	2.4	4.5	0.9	2.0	2.0	1.9	2.4	2.4	2.8	2.0
11	Cookies, brownies, cakes	2.4	2.1	1.4	2.1	2.5	3.0	2.5	2.2	2.0	2.6
12	Burgers	2.4	2.3	1.0	2.5	2.5	2.3	2.0	2.5	2.4	2.3
13	Meat mixed dishes	2.3	2.0	1.9	2.1	2.5	2.2	2.5	2.2	2.3	3.0
14	Tomato-based condiments	2.3	3.1	1.2	2.7	2.1	2.2	1.8	2.6	2.6	2.1
15	Poultry mixed dishes	2.3	1.6	2.6	1.7	2.5	2.7	1.7	2.6	2.7	2.2
16	Eggs and omelets	2.1	2.4	1.0	2.1	2.2	1.7	1.9	2.2	2.3	2.2
17	Egg sandwiches	2.0	1.6	1.3	2.0	2.1	2.2	2.1	1.9	1.9	2.3
18	Cold cuts and cured meats (excluding sandwiches)	1.9	1.5	1.1	0.7	2.3	2.3	2.0	1.9	1.6	2.2
19	Chicken nuggets and tenders	1.9	2.4	1.6	2.5	1.7	1.4	2.1	1.7	1.4	1.3
20	Bacon, frankfurters, sausages (excluding sandwiches)	1.8	1.2	0.7	3.5	1.8	2.1	1.7	1.9	1.5	2.1
21	Rice	1.8	2.6	7.6	1.8	0.9	2.5	2.3	1.6	2.0	1.4
22	Mashed, baked, or boiled white potatoes	1.6	1.0	0.8	1.7	1.9	1.6	1.5	1.8	1.6	2.0
24	Fried white potatoes	1.5	1.4	0.6	1.9	1.5	1.7	1.3	1.6	1.6	1.5
25	Dips, gravies, other sauces	1.5	2.3	1.0	0.8	1.4	1.7	1.1	1.7	1.5	1.5
Among the top 10 contributors to sodium intake within a subgroup (not among the top 25 contributors overall)											
26	Poultry sandwiches	1.4	1.0	0.9	1.4	1.5	2.7	0.9	1.7	1.6	1.3
27	Quesadillas, tamales, fajitas, and enchiladas	1.4	3.7	0.9	0.5	1.0	0.7	1.2	1.5	1.8	1.0
32	Beans, peas, legumes	1.2	2.0	2.7	1.0	0.9	0.5	1.2	1.1	1.3	1.0
35	Stir-fry and soy-based sauce mixtures	1.1	1.1	2.0	0.5	1.1	0.7	0.7	1.3	1.2	1.1
37	Rice mixed dishes	1.0	1.6	5.3	0.9	0.5	0.6	0.8	1.3	1.4	0.7
Sodium intake											
	Daily sodium intake, mean (SE), mg	3,103 (30)	2,921 (96)	3,438 (195)	2,916 (62)	3,174 (39)	3,024 (98)	3,065 (41)	3,158 (45)	3,224 (37)	3,184 (50)
	Daily sodium density, mean (SE), mg/1,000 kcal	1587 (10)	1,590 (34)	1,713 (47)	1,610 (17)	1,574 (13)	1,542 (24)	1,531 (13)	1,620 (10)	1,618 (21)	1,611 (15)

% of sodium intake	0–0.9	1.0–1.9	2.0–2.9	3.0–3.9	4.0–4.9	≥5.0

Figure 2. Top food category contributors to sodium intake among those aged 1 year or older, by race and ethnicity, overweight or obesity, and hypertension. National Health and Nutrition Examination Survey, August 2021–August 2023. Gray shading indicates a relative SE ≥0.30; estimate is therefore statistically unreliable.

Foods representing at least 2.5% of total sodium intake (Figure 1) were, in descending order, deli meat sandwiches (5.0%); pizza (4.4%); savory snacks (eg, chips, crackers, popcorn, 4.4%); soups (4.4%); poultry (excluding nuggets and tenders, 3.8%); pasta mixed dishes (excluding macaroni and cheese, 3.8%); breads, rolls, and buns (3.1%); and cheese (including cottage cheese and ricotta, 2.7%) (Table).

Generally, the top food category contributors to sodium intake across age groups were the same, with some exceptions. For example, among children aged 1 to 11 years, savory snacks were the largest contributor to sodium intake, at approximately 8%, but among other age groups, savory snacks made up a smaller proportion of sodium intake. Among children aged 1 to 4 years, unflavored milk was the fifth-largest contributor to sodium intake (4.6%), but among other age groups, unflavored milk made up 0.6% to 2.0% of sodium intake.

The distribution of top contributors varied by race and ethnicity (Figure 2). Among Hispanic participants, the quesadillas, tamales, fajitas, and enchiladas food category represented 3.7% of sodium intake and was the sixth-largest contributor to sodium intake yet was not among the top 25 contributors overall. Among non-Hispanic Asian participants, soups and rice were the top 2 contributors, representing 16.3% of total sodium intake. Among non-Hispanic Black participants, poultry was the top contributor (7.3%), while among participants from the other racial and ethnic groups, poultry represented 3.0% to 4.2% of sodium intake.

Discussion

In a nationally representative sample of children and adults, the top contributors to sodium intake were generally similar across age groups for adults, with some differences across age groups among children and by racial and ethnic group. Most top contributors to sodium intake were the same as those found in prior NHANES studies (3,4). Rankings of the top contributors to sodium intake differed slightly from the rankings found in prior NHANES studies, although it is unclear to what extent differences are due to actual dietary changes, random variation, and/or changes in the food categories used by NHANES.

Limitations include self-reported dietary data, which are subject to recall bias. Sodium intake might be misclassified in some instances; it might be underestimated because salt added at the table was excluded from dietary recalls or overestimated because USDA data assumes salt was added to certain foods (eg, rice). Although survey weights adjusted for nonresponse bias, this bias might have affected results, because the rate of participation in the examination was 25.7% (5). Results may not be comparable with other studies because of different methods of categorizing foods. Lastly, estimates for food categories in some groups, particularly children aged 1 to 4 years and non-Hispanic Asian participants, were not statistically reliable due to insufficient sample sizes.

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Our findings might be used to tailor interventions to more effectively reduce sodium intake. Because population-level interventions can have the greatest impact on reducing sodium intake (11), knowledge of the top contributors of sodium intake might be helpful to consumers seeking lower-sodium products and might support food manufacturers' implementation of the voluntary sodium reduction goals of the US Food and Drug Administration (12). Bread and bread-containing foods made up multiple top food categories contributing to sodium intake, and salt in bread may be reduced by approximately 40% without substantially affecting consumer acceptability (13). Moreover, because a wide variety of foods contributes to sodium intake, interventions can focus on multiple foods rather than any single food. When top contributors to sodium intake among certain demographic groups differ from those seen among the overall population, interventions can be tailored appropriately. For example, interventions for children can focus on lower-sodium alternatives for savory snacks served in settings such as early care and education facilities and schools. Information on top contributors of sodium intake might enhance schools' capacity to meet recently updated federal guidelines on sodium limits for school meals (14). At the individual level, increased education and awareness might help consumers identify their greatest sources of sodium intake. Counseling by health care providers and consumer education efforts at reducing dietary sodium can complement other food system–level interventions (15).

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Table

Table. Characteristics of Children and Adults Aged ≥1 Year, National Health and Nutrition Examination Survey, August 2021–August 2023[a]

Characteristic	Overall (n = 6,633)		Children (aged 1–17 y) (n = 1,652)		Adults (≥18 y) (n = 4,981)	
	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)	No.
Age, y						
1–4	4.3 (3.7–4.8)	351	20.0 (17.1–22.8)	351	—	—
5–11	9.1 (8.0–10.1)	732	42.4 (40.2–44.7)	732	—	—
12–17	8.0 (7.3–8.8)	569	37.6 (35.4–39.9)	569	—	—
18–39	29.6 (27.5–31.8)	1,301	—	—	37.7 (35.0–40.3)	1,301
40–59	25.4 (23.9–26.9)	1,328	—	—	32.3 (30.2–34.4)	1,328
≥60	23.6 (21.6–25.6)	2,352	—	—	30.0 (27.9–32.2)	2,352
Sex						
Female	50.8 (49.5–52.1)	3,613	48.6 (46.4–50.9)	840	51.4 (50.0–52.8)	2,773
Male	49.2 (47.9–50.5)	3,020	51.4 (49.1–53.6)	812	48.6 (47.2–50.0)	2,208
Race and ethnicity						
Hispanic	18.7 (12.7–24.7)	1,305	25.2 (17.9–32.5)	477	17.0 (11.2–22.8)	828
Non-Hispanic Asian	5.7 (3.4–7.9)	327	7.7 (4.6–10.8)	113	5.1 (3.0–7.2)	214
Non-Hispanic Black	11.6 (8.6–14.5)	823	12.1 (9.0–15.1)	244	11.4 (8.2–14.6)	579
Non-Hispanic White	57.9 (53.6–62.3)	3,716	46.6 (40.3–52.9)	669	61.0 (57.0–65.0)	3,047
Non-Hispanic Other[b]	6.1 (5.0–7.2)	462	8.4 (6.1–10.8)	149	5.5 (4.3–6.7)	313
Overweight or obesity[c]						
No	34.4 (31.5–37.2)	2,314	60.1 (57.5–62.7)	968	27.4 (24.2–30.5)	1,346
Yes	63.5 (60.6–66.4)	4,156	33.1 (29.4–36.8)	578	71.7 (68.6–74.9)	3,578
Missing	2.1 (1.9–2.4)	163	6.8 (4.9–8.6)	106	0.9 (0.6–1.1)	57
Hypertension[d]						
No	—	—	—	—	51.2 (48.9–53.6)	2,219
Yes	—	—	—	—	47.2 (45.0–49.5)	2,693
Missing	—	—	—	—	1.5 (1.0–2.0)	69

Abbreviation: —, does not apply.

[a] Reported values were estimated using the "survey" package in R version 4.5.0 (R Foundation), adjusting for the complex survey design and estimating variance using Taylor series linearization. Survey weights from day 1 dietary recall were used.

[b] Includes American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, and "other."

[c] Overweight or obesity was based on body mass index ≥85th percentile for individuals aged 2–19 years based on age- and sex-specific thresholds provided by the Centers for Disease Control and Prevention (8). For those aged ≥20 years, overweight or obesity was based on body mass index ≥25 kg/m^2, based on criteria from the World Health Organization (9).

[d] Hypertension was defined as a systolic pressure ≥130 mm Hg or diastolic pressure ≥80 mm Hg (based on criteria from the American Heart Association) (10) or self-reported use of hypertension medication. Hypertension was not evaluated for children aged ≤17 years.

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ORIGINAL RESEARCH

Ultraprocessed Foods in Popular Children's Television Series

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PEER REVIEWED

Summary

What is already known about this topic?

Processed foods are prevalent in children's television programming. The degree of their processing according to the NOVA system has not been extensively examined.

What is added by this report?

We examined food-related content in popular children's media, considering the degree of food processing and geographical origin. Ultraprocessed foods (UPF) were the most abundant foods in broadcasts; European cartoons had a greater number of UPF compared with North American cartoons.

What are the implications for public health practice?

Television series can negatively influence children's dietary choices. Public health programs in cooperation with media producers can use these findings to create healthier media representations and promote children's well-being.

Abstract

Introduction

Research on children's television programming examining the quality of presented foods finds a prevalence of processed foods, though the degree of processing of the foods shown has not been extensively examined. This study aims to assess the quality of the food presented in popular children's television series, based on the NOVA food classification system, and distinguish between the way foods are presented.

Methods

We selected 100 episodes of 10 cartoon television series that had large audiences of children. Food items, either eaten by heroes or introduced visually or verbally in television series, were recorded per episode. They were then classified according to the NOVA system. Differences by the series continent of origin (Europe, North America, or Asia) were also examined.

Results

The median number of food recordings per episode was 3.0, with most (61.5%) classified as foods introduced visually or verbally. More than half of all foods featured per episode were ultraprocessed foods (UPF) and one third of them were minimally processed foods (MPF), while other NOVA food categories rarely appeared. Both UPF and MPF were presented more often as foods introduced visually or verbally rather than as foods eaten, but UPF represented 72% of the foods eaten per episode. European cartoons broadcasted more UPF items compared with North American television series.

Conclusion

UPF dominated in children's television series, especially those of European origin, raising a public health concern for Europe.

Introduction

Research on children's television programming and children's movies examining the quality of presented foods finds a prevalence of processed foods. For example, sugar-sweetened beverages and unhealthy snacks are notably common in children's movies (1) and adolescents' television shows (2), while another study indicates that nearly twice the amount of airtime in children's television programming is devoted to showcasing unhealthy foods with high sugar and processed fat content (3). By considering visual, verbal, or actual eating scenes within children's animated programs it has been noted that sweets, salty snacks, and sugar-sweetened beverages accounted for 42% of all representations (4). Our research team has also found that convenience food items, such as sweets and salty snacks, prevail in terms of actual consumption in popular children's programming (5,6).

Several classifications of broadcast foods relating to healthiness or unhealthiness have been used in earlier publications. Foods have

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been categorized in national food recommendations as nutritious or nonnutritious (7); healthy, unhealthy, or neutral (1); or healthy, mixed, and unhealthy (8). Some studies provide a food-centered categorization of the items (ie, dairy, beverages, snacks, desserts) (5,9,10). Olafsdottir and Berg (11,12) have classified foods as "high calorie–low nutrient" and "fruits and vegetables." During recent decades, another parameter that has been gaining popularity as an indicator of the healthiness or unhealthiness of food is the degree of processing, in terms of nature, extent, and purpose, which is described in the NOVA classification system (13). Ultraprocessed foods (UPF) encompass ready-to-eat as well as ready-to-heat foods, produced through industrial methods. Some examples of UPF are cereal bars, savory snacks, processed meats, prepackaged frozen meals, soft drinks, sweetened beverages, instant soups, and sauces (14). UPF consumption has raised concern regarding its association with impaired health outcomes, such as obesity and other cardiometabolic disease risk factors (15). This link may be partially explained by the fact that they are palatable and "comfort" foods but are also calorie-dense, high in fat, and low in dietary fiber (16). The degree of processing of foods shown in cartoons has not been extensively examined by previous research; Horta et al (17) use the widely accepted, international classification of the NOVA food system to categorize foods. Moreover, because UPF consumption varies among countries (18) and because cartoons may be seen as a reflection of the cultures and everyday life habits of a place, it would be interesting to investigate the food-related content of children's television programming in relation to its geographical origin, an aspect that has been rarely studied (19,20).

The objective of our study was to classify all food items presented in popular children's television series in Greece according to the NOVA system. Moreover, as food marketing employs both explicit and implicit messages to influence children's behavior (21), distinguishing between the way the foods are presented may be of interest. We aimed to distinguish between foods shown to be ingested on screen and those that were presented solely verbally or visually. We also examined relevant disparities pertaining to the cartoon's geographic origin.

Methods

Selection of television series

We selected 100 episodes of the 10 most popular television series, based on audience ratings in Greece, presented to children (aged 4 to 14 years). On request, the Nielsen Audience Company submitted data showing broadcasting ratings for the months of October 2011 and June 2012. The audience ratings were based on the Average Minute Rating (AMR) scale, which measures the percentage of the population in the target group watching a program during the average minute of a given period. Out of the 84 broadcasted television series, 22 had an AMR rating exceeding 7%. Among the latter, our study focused on the top 10 series (all cartoons), having an AMR of 9.5% or higher, which were *Ben 10*, *Dora the Explorer*, *Jewelpet*, *Lazy Town*, *Penguins of Madagascar*, *PitchiePitchie Pitch*, *SpongeBob SquarePants*, *Teen Days*, *Tom and Jerry*, and *Tutenstein*.

The selected television series were classified according to the country of production, then the countries were grouped into their respective continents. Three production continents were identified:

1. Asia: *Jewelpet* and *PitchiePitchie Pitch* (Japan).
2. North America: *Ben 10*, *Dora the Explorer*, *Penguins of Madagascar*, *SpongeBob SquarePants*, *Tom and Jerry*, and *Tutenstein*.
3. Europe: *Teen Days* (Italy) and *Lazy Town* (Ireland).

Classification of foods featured in the episodes

Food classification by presentation

All food items shown in the television series were recorded. Whenever a cartoon character (whether primary or secondary, human or animal) mentioned or ate a food or a drink, this item was recorded. All noningested foods and actual eating situations were recorded, irrespective of whether they were integral to a central scene or existed in the surroundings. Two independent raters with a background in nutrition science viewed all 100 episodes. In cases where a food item was eaten by a character, the food was classified as "foods eaten," while foods and drinks presented on screen or verbally discussed among the cartoon characters were classified as "foods introduced visually or verbally." Foods presented visually referred to food items that were depicted on screen (eg, an apple, a cake, a bowl with corn flakes being on the table during breakfast time). Foods presented verbally were those for which any kind of food-related aspect was expressed by cartoon heroes; for example, some sensorial properties (ie, smell, taste, texture, color, shape), or implications by the heroes about their consumption or nutritional value.

Recording and counting of the food items was based on the assumption that for every food item featured in any way, 1 item was recorded. For multiple food items featured, each one of them was counted separately. For instance, if the raters observed a cartoon character eating an apple in an episode's scene, they recorded 1 item of apple. If a plate with various food items such as chicken, rice, and lettuce was portrayed, then 3 items were counted. Eating occasions with an extreme consumption were not included in the analysis (ie, one case of a character binge-eating). Other foods ex-

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cluded from recording were those where the food could not be specified.

Food classification using the NOVA system

Foods reviewed were classified according to the NOVA food system (14). The NOVA food classification system categorizes foods into 4 groups based on the level of processing: unprocessed or minimally processed foods (MPF), processed culinary ingredients (PCI), processed foods (PF), and UPF. Foods in these categories can be exemplified as follows: MPF includes fruits, vegetables, nuts, and eggs; PCI includes olive oil, sugar, honey, and butter; PF includes tomato paste, freshly made cheeses, and canned fish; and UPF includes fast foods, soft drinks, processed breads, biscuits, breakfast cereals, and sweetened yogurts (14). Classification of food items according to the NOVA system was done by the 2 raters who recorded the foods featured, with high degree of agreement between them. In case of disagreement, a third researcher was involved, and a group discussion was carried out. It should be noted, however, that as it is difficult to distinguish between homemade and industrially made foods projected in cartoon series, raters agreed to a priori categorize certain kinds of foods (eg, cakes, cereal bars, hot dogs, burgers, salty snacks) as UPF foods (13) unless otherwise stated in the episode.

Statistical analysis

Descriptive statistics include the frequencies (absolute numbers) and percentages of foods eaten, foods introduced visually or verbally, and all foods featured per episode for all NOVA categories (ie, MPF, PCI, PF, and UPF). As the variables investigated were nonnormally distributed (Kolmogorov-Smirnoff criterion), values are presented as medians and interquartile ranges (Q2 [Q1–Q3], where Q2 = median; Q1 = 25th percentile; Q3 = 75th percentile), and nonparametric tests were applied for statistical comparisons. The Mann–Whitney and Kruskal–Wallis tests were used to test the differences between 2 or more categories, respectively. For post hoc analysis we used the Dunn test, in cases where a significant main effect was found. We used Bonferroni adjustment for multiple comparisons. Statistical significance for all tests was defined at $\alpha = .05$. We used Stata version 17 (Stata Corp LP) software for all statistical analyses.

Results

The food items featured in the episodes analyzed are listed in the Box, as classified according to the NOVA system, and Table 1 presents the frequencies of foods of each NOVA category per episode. Across 100 episodes, 457 foods were shown, with a median number recorded per episode of 3.0 (1.6–6.0). Among them, 176 (38.5%) were categorized as foods eaten, and the remaining 281 (61.5%) were classified as foods introduced visually or verbally. In 40 episodes, no MPF items were featured, while the number of episodes with no recordings of UPF items was 30. PCI and PF items were rarely featured. In all episodes reviewed, foods characterized as PCI were presented 5 times, of which 2 were shown to be eaten (olive and peanut butter). Foods characterized as PF items were presented 24 times, of which 9 concerned actual consumption (wine, canned fruits, and fish) and 15 visual presentations (eg, wine, cheese, pickles) (Table 1). While both UPF and MPF items were presented more often as foods introduced visually or verbally rather than as foods eaten (161 vs 117 of 278 recordings, and 102 vs 48 of 150 recordings) (Table 1), within the foods eaten per episode, 72.0% (33.3%–100%) were UPF, a median percentage that was significantly high compared with that of the other NOVA categories (Table 2). Moreover, the percentage of foods introduced visually or verbally or the percentage of all foods featured per episode did not differ between foods in the UPF and MPF categories (Table 2).

Box. Foods and Beverages Presented in Television Series, by NOVA Food System Categories

Minimally Processed foods

Tomato, carrot, lettuce, coconut, apple, vegetables, sugarcane, eggs, banana, nuts, fruit, watermelon, corn, papaya, orange, kiwi, apple, apple juice, pear, meat, ground meat, chicken, fish, turkey, seafood, onion, cherries, milk, grapefruit, ravioli, beans, coffee, tea, fish

Processed Culinary Ingredients

Olive, peanut butter, pickles

Processed Foods

Wine, cheese, canned fruits, canned fish

Ultraprocessed Foods

Biscuit, ice cream parfait, candies, cotton candy, chocolate smoothie, croissant, bread, salty snack, biscuit, birthday cake, ice cream, soda, sandwich, sausage, pizza, lollies, sweets, pancakes, cake, bread, hot dog, pizza, sandwich, ketchup, hamburger, popcorn, candies, hot chocolate, corn flakes

Table 3 presents the differences between continents in the percentage of the foods in a NOVA food category that were presented in different ways (eaten, introduced visually or verbally, and all foods shown), per episode (Appendix). A significant difference was reached only for all UPF items featured and the UPF items introduced visually or verbally. Pairwise comparisons showed that European series broadcasted more UPF items (total UPF items and UPF items introduced visually or verbally) per episode compared with Northern American ones. There were no significant differences for MPF or PF items between the regions.

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Discussion

We found that UPF were the most abundant foods broadcasted in all the episodes analyzed, while they constituted the most frequent NOVA category presented to be eaten in a typical episode. Only MPF were highly present in the television series studied, with a similar percentage of foods introduced visually or verbally in an episode compared with UPF in an episode. Additionally, European cartoons broadcasted more UPF items compared with North American cartoons.

In children's television programming, research has shown that unhealthy foods are prominently featured (3,5,20). The food content we found herein pertains to UPF. However, the NOVA food system is not widely used as a medium for food classification in this context. Nevertheless, our findings align with those of other researchers using different food classification methods who also identified processed foods, such as sweets, as the second most common type of food depicted in children's programming (20). In the meantime, an analysis of the nutritional content of foods featured on US television programs indicated that the total airtime for unhealthy food depictions was nearly twice as much as that for healthy food (3), while a study examining food consumption and gender disparities in popular television series found twice as many noncore foods (eg, sweets) consumed compared to core foods (eg, fruits) (22).

These depictions have raised concern in regard to their potential influence on children's food behavior. A systematic review and meta-analysis on this issue found that in experimental studies children consumed more unhealthy calories than healthy ones after being exposed to unhealthy food marketing, with younger children being more susceptible to marketing techniques (23). Advertisements presented to children predominantly promote processed foods (24,25), including advertisements shown on YouTube (26). Another systematic review identified a range of food marketing techniques, with "television/movies" being the most studied vehicle in this respect; data showed that marketing influenced children's consumption and attitude toward the advertised foods (21). However, the authors discussed the difference between implicit and explicit messages of food marketing as an area of future research, to enhance understanding of its impact. Our study found that UPF were eaten more frequently than foods of other NOVA categories, which seems to be closer to an explicit message for consumption; namely, eating the food is a stronger cue for modeling the food behavior than mere food presentation is, according to the social theory of learning (27).

Regarding the presence of healthier foods in the relevant literature, even with other than the NOVA classification systems, this is disappointing. Television series show a minimal representation of less-processed foods, including dairy, cheese, eggs, fruits, and vegetables (5,20). More particularly, Anderson and Anderson (7) found that television rarely showcased vegetables, ranking them as the second least-presented food item, while fruits primarily served decorative purposes rather than being depicted as nutritious sources of energy. Vegetables are minimally represented in children's programming, particularly in shows created for tweens, as highlighted by Eisenberg et al (2). However, findings of our study showed an equal presentation of MPF and UPF per episode, which may be attributed to a series of educational context. For example, *Dora the Explorer* appeared to contain healthier food choices, while UPF items were rarely featured and even less frequently consumed. A more pedagogical content in the *Dora* series was also noted by Angin (28). Also, some of the older series in our sample, such as *Tom and Jerry*, clearly featured less UPF and more MPF. Although it was not the focus of our study, we noted that there also seems to be a neutral perception of healthier foods, such as fruits, in children's programming. While fruits are sometimes associated with neutral or unfavorable meanings (5), vegetables receive even less attention, typically in neutral contexts (5,17). Additionally, Oates and Newman (29) noted that fruits, despite their visibility, were often used as background elements or props in children's television shows. Our analysis also found that MPF items such as fruits and vegetables were primarily shown on screen but were not typically included in actual eating scenes.

Regarding the differences in results based on the continent of production, our study showed that European cartoons had a greater number of UPF compared with North American cartoons. Few other studies have investigated the food-related content of children's television programming in relation to its geographical origin. A study assessing the educational value of food placements in 250 children's movies examined the potential variations in food messages across different continents (19). European series exhibited the highest frequency of food placements; however, North American series were more inclined to depict noneducational food messages — particularly those endorsing foods of low nutritional value, such as sweets or sugary products — in a positive light by the characters. On the other hand, the duration of educational placements promoting healthier foods was significantly longer in Asian series than in European or North American ones (19). Scully et al (30) compared data from children's programming in UK and Irish television stations regarding the frequency and type of foods presented. Most of the selected television programs (89%) in both television stations were produced in the US, the UK, or Ireland. However, in their report, the researchers opted not to categorize them based on the country of production. Li et al (10) found that many food references in Chinese programs viewed by children concerned healthy products.

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To the best of our knowledge, this is the first study examining food-related content in popular children's media that considers the degree of food processing and geographic origin. Nevertheless, the contribution of the study could be clarified and strengthened for public health nutrition, acknowledging certain limitations. One important temporal limitation is that the series we examined were broadcasted exclusively between 2011 and 2012, which restricts the years of data coverage and means the data are more than a decade old. However, this is balanced by certain strengths, as these data reflect the state of television productions during those years and could well serve as a point of comparison for later periods. Also, even though it is conceivable that the content of series may have changed, many of these are still broadcast in their original form and continue to circulate widely via global syndication, streaming platforms, and cultural references. For example, the television series *Dora the Explorer* continues to be currently broadcast, despite the release of a new series featuring the protagonist as an adolescent. *Lazy Town* has been relicensed and aired globally, with recent deals including broadcasts in Latin America, French-speaking Canada, Eastern Europe, Slovenia, and Benelux (31). Another limitation is that the sample size was limited to a selection of series broadcasted on Greek television channels. The top 10 series in terms of audience viewership were purposefully chosen, but these may not fully represent the entire spectrum of available content. However, many of the cartoons examined herein enjoy universal acceptance, such as *Dora the Explorer*, *Tom and Jerry*, *SpongeBob SquarePants*, or *Penguins of Madagascar*. In addition, the NOVA system has some inherent limitations because debatable whether the degree of processing per se affects the nutritional value of a product is debatable (32), and some researchers believe that nutrient analysis is advantageous in this regard (33). Moreover, UPF products cannot always be easily distinguished. For example, industrial bread containing only wheat flour, water, salt, and yeast, is a PF, while if it contains emulsifiers or colors it is a UPF.

This study demonstrated the dominating presence of UPF in children's television series. Moreover, it showed that UPF were more prevalent in the series produced in European countries compared with those from other continents. Since messages conveyed through television series may have negative consequences on children's dietary choices in real life, it would be of benefit to the public to modulate the food content portrayed in television programs and create a media environment that fosters children's health and well-being by promoting healthy stereotypes. In this respect, the collaboration of groups such as broadcasters, content creators, and regulatory bodies, along with enforcement and public awareness, could increase the effectiveness of public health programs created for children.

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Tables

Table 1. Foods Featured in 100 Television Episodes of Popular Children's Television Series,[a] Analyzed by NOVA Category[b]

Classification	No. (%)				
	Minimally processed foods	Processed culinary ingredients	Processed foods	Ultraprocessed foods	Total
Foods eaten	48 (27.3)	2 (1.1)	9 (5.1)	117 (66.5)	176 (100)
Foods introduced visually or verbally	102 (36.3)	3 (1.1)	15 (5.3)	161 (57.3)	281 (100)
All foods featured	150 (32.8)	5 (1.1)	24 (5.3)	278 (60.8)	457 (100)

[a] Episodes broadcast in October 2011 and June 2012 were from the series *Ben 10*, *Dora the Explorer*, *Jewelpet*, *Lazy Town*, *Penguins of Madagascar*, *PitchiePitchie Pitch*, *SpongeBob SquarePants*, *Teen Days*, *Tom and Jerry*, and *Tutenstein*.
[b] Categories described in Monteiro et al (13).

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Table 2. Differences in the Classification of Foods, by NOVA Food Category,[a] Among Foods Presented Per Episode of Popular Children's Television Series[b]

Classification	Percentage of items per episode[c]				
	Minimally processed foods	Processed culinary ingredients	Processed foods	Ultra-processed foods	*P* value
Foods eaten	0.0 (0.0–50.0)[z]	0.0 (0.0–0.0)[y]	0.0 (0.0–0.0)[y]	72.0 (33.3–100)[x]	<.001
Foods introduced visually or verbally	33.3 (0.0–66.6)[z]	0.0 (0.0–0.0)[y]	0.0 (0.0–0.0)[y]	55.5 (0.0–100)[z]	<.001
All foods featured	30.3 (0.0–61.9)[z]	0.0 (0.0–0.0)[y]	0.0 (0.0–0.0)[y]	58.5 (25.5–97.7)[z]	<.001

[a] Categories described in Monteiro et al (13).
[b] Episodes broadcast in October 2011 and June 2012 were from the series *Ben 10*, *Dora the Explorer*, *Jewelpet*, *Lazy Town*, *Penguins of Madagascar*, *PitchiePitchie Pitch*, *SpongeBob SquarePants*, *Teen Days*, *Tom and Jerry*, and *Tutenstein*.
[c] Percentages are for median values and interquartile ranges (Q2 = median; Q1 = 25th percentile; Q3 = 75th percentile). The Mann–Whitney test was used to test the differences between categories. Post hoc analysis was performed by using the Dunn test in cases where a significant main effect was found. Different letters (x, y, and z) denote significant differences in variables.

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Table 3. Differences in the Classification of Foods, by NOVA Food Category[a], Per Episode of Popular Children's Television Series[b], by Series Continent of Origin[c]

Category	Percentage of items per episode[d]			
	Asia	Europe	North America	*P* value
Minimally processed foods				
Foods eaten	0.0 (0.0–100)	0.0 (0.0–50.0)	0.0 (0.0–58.3)	.72
Introduced visually or verbally	55.5 (0.0–100)	22.5 (0.0–44.6)	33.3 (0.0–100)	.12
All foods featured	36.6 (0.0–64.3)	20.0 (11.1–33.3)	33.3 (0.0–66.6)	.35
Processed culinary ingredients				
Foods eaten	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	.34
Introduced visually or verbally	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	.76
All foods featured	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	.48
Processed foods				
Foods eaten	0.0 (0.0–50.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	.08
Introduced visually or verbally	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	.07
All foods featured	0.0 (0.0–8.3)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	.11
Ultraprocessed foods				
Foods eaten	50.0 (0.0–100)	100 (50.0–100)	71.4 (33.3–100)	.62
Introduced visually or verbally	45.0 (0.0–100)	77.5 (55.3–100)[e]	50.0 (0.0–100)	.03
All foods featured	50.0 (0.0–100)	80.0 (66.6–88.8)[f]	50.0 (0.0–100)	.04

[a] Categories described in Monteiro et al (13).
[b] Episodes broadcast in October 2011 and June 2012 were from the series *Ben 10*, *Dora the Explorer*, *Jewelpet*, *Lazy Town*, *Penguins of Madagascar*, *PitchiePitchie Pitch*, *SpongeBob SquarePants*, *Teen Days*, *Tom and Jerry*, and *Tutenstein*.
[c] For each continent of origin, and within each NOVA food category, the value in the cell is the percentage of that NOVA food category to the total number of foods eaten or introduced visually or verbally or totally featured, respectively. For example, the value 80.0 for the ultraprocessed foods featured totally in Europe, means that 80.0% of all foods featured in European series were ultraprocessed foods.
[d] Percentages are for median values and interquartile ranges (Q2 = median; Q1 = 25th percentile; Q3 = 75th percentile). The Kruskal–Wallis test was used to test the differences between categories. Post hoc analysis was performed by using the Dunn test, in cases where a significant main effect was found. Bonferroni adjustment was performed for multiple comparisons. Pairwise comparisons were applied only when a significant difference was detected between groups.
[e] Significant pairwise comparisons, Europe vs North America, $P = .03$.
[f] Significant pairwise comparisons, Europe vs North America: $P = .04$.

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Appendix

Appendix Table. Number of Foods in the Total Sample of Television Episodes Analyzed, by NOVA Food Category[a] and by Continent of Country of Production

Category	Asia	Europe	North America
Minimally processed foods			
Foods eaten	8	9	31
Introduced visually or verbally	18	22	62
All foods featured	26	31	93
Processed culinary ingredients			
Foods eaten	0	0	2
Introduced visually or verbally	0	1	2
All foods featured	0	1	4
Processed foods			
Foods eaten	4	0	5
Introduced visually or verbally	0	0	15
All foods featured	4	0	20
Ultraprocessed foods			
Foods eaten	10	53	54
Introduced visually or verbally	12	58	91
All foods featured	22	111	145

[a] Categories described in Monteiro et al (13).

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ORIGINAL RESEARCH

Geographic Differences in Obesogenic Behaviors and Overweight and Obesity Among Children and Adolescents

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PEER REVIEWED

Summary

What is already known on this topic?

Children from rural areas are more likely to be overweight or obese than children from urban areas. Recent research examining rural–urban differences in overweight and obesity, physical activity, and food security among children has not examined screen time or sleep guidelines.

What is added by this report?

This is the first study, to our knowledge, to examine geographic differences in the prevalence of overweight and obesity, food security, and obesogenic behaviors (ie, physical activity, sleep time, and screen time), using a national sample of children and adolescents.

What are the implications for public health practice?

Findings should be useful for program developers as interventions are designed to improve children's health behaviors, particularly around sleep and sedentary behavior, in the US.

Abstract

Introduction

Geographic disparities in childhood obesity have been demonstrated, but research examining differences in obesogenic behaviors by rurality is limited. This study examined children's rates of overweight and obesity, food security, and obesogenic behaviors (ie, physical activity, sleep time, and screen time) by rurality and the association between rurality and these 5 outcomes.

Methods

We analyzed cross-sectional data on children and adolescents aged 10 to 17 years (N = 35,963) from the 2021–2022 National Survey of Children's Health, a nationally representative sample of children and adolescents. Frequencies, proportions, and unadjusted results were calculated by using descriptive statistics and bivariate analyses. Multivariable logistic regression models were used to study the relationship between rurality and the 5 outcomes.

Results

Compared with urban children, rural children had higher odds of being overweight or obese (adjusted odds ratio [AOR] = 1.36; 95% CI, 1.19–1.56), being food insecure (AOR = 1.27; 95% CI, 1.11–1.44), and not meeting the recommended hours of sleep (AOR = 1.23; 95% CI, 1.07–1.40); and they had lower odds of being physically inactive (AOR = 0.79; 95% CI, 0.70–0.90) and having more than 2 hours of screen time on an average day (AOR = 0.85; 95% CI, 0.75–0.96).

Conclusion

The findings from this study are instructive for community partners and program developers in creating policies and programs that allow for multitiered interventions to promote positive health behaviors to reduce overweight and obesity among all children and adolescents.

Introduction

Health during childhood is strongly associated with health during adolescence and into adulthood (1), making it critical that interventions and programs prioritize children's health (2). The lasting effect of childhood health has been demonstrated for conditions such as obesity and poor mental health (3,4), yet many chronic conditions, such as obesity, are increasing in the US (5).

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The prevalence of childhood obesity has increased in the US, from an estimated prevalence of 14.7% in 1999 to 19.2% in 2018 (6). The most recent data put the proportion of children and adolescents with obesity at nearly 20%, with one of the Healthy People 2030 goals of reducing obesity among children and adolescents to 15.5% (7). Many health behaviors, deemed obesogenic behaviors, may contribute to the increasing rate of childhood obesity; these include the amount of physical activity and screen time children engage in and whether they receive the recommended amount of sleep (8–10). Food insecurity has also been associated with obesity from childhood into adulthood (11). Understanding these contributing factors to childhood obesity is imperative for improving efforts to reduce rates of obesity.

The proportion of US children who are overweight or obese is not evenly distributed. Rural children and adolescents are more likely to be overweight or obese than urban children and adolescents (12). Just under 20% of US children reside in rural areas, where the poverty rate is 25% higher than in urban areas (13). Higher poverty rates, which are associated with lower health literacy among rural children and their caregivers, may contribute to the overall poorer health status of rural children and adolescents (14,15).

More recent research examining rural–urban differences in overweight and obesity, physical activity, and food security among children and adolescents did not examine screen time or sleep guidelines (12). Yet, experiencing lower than recommended hours of sleep and higher than recommended hours of screen time is strongly associated with childhood obesity (9,16). Therefore, an updated and expanded study of obesogenic behaviors by rurality is needed. Previous studies on geographic differences in screen time and physical activity focused on populations outside the US (17), was limited to adults (18), was limited to 1 state (19), or used data that were more than a decade old (20). Therefore, an examination using updated national data of geographic differences in overweight and obesity, physical activity, food security, and recommended sleep and screen time guidelines met, is needed.

The objective of this study was to 1) examine rates of overweight and obesity, food security, and obesogenic behaviors, specifically physical activity, sleep time, and screen time, by rurality; and 2) examine the association between rurality and these 5 outcomes among a national sample of children and adolescents aged 10 to 17 years. We hypothesized that rural children and adolescents would have higher rates of all 5 outcomes, compared with their urban counterparts. The findings from this study should be useful for program developers as interventions are designed to improve health behaviors, particularly around sleep and sedentary behavior, in the US.

Methods

We used data for this cross-sectional study from the 2021 and 2022 National Survey of Children's Health (NSCH). The NSCH is a nationally representative survey sent online and via mail to adults aged 18 years or older who are caregivers of a child aged 0 to 17 years and randomly selected by the NSCH survey software. The NSCH includes questions about the health of the randomly selected child. The NSCH in 2021 and 2022 had 104,995 completed interviews, and results were weighted according to the population of US children.

Study sample

We restricted our study to children and adolescents aged 10 to 17 years due to the suppression of weight information for children younger than 10 years in the NSCH; this restriction resulted in a sample size of 44,887. Furthermore, only participants that identified whether they lived in a rural or urban area were included, which reduced our sample size to 35,963. Children who lived in a metropolitan area (ie, area with a population of ≥50,000) were considered urban residents and those who did not live in a metropolitan area (ie, area with a population of <50,000) were considered rural residents, based on the rurality definition of the Office of Management and Budget. The NSCH does not release data on residence for states whose population of children is less than 100,000. The following states did not have data on residence in the 2021 and 2022 NSCH: Delaware, Maine, New Hampshire, North Dakota, South Dakota, Vermont, and Wyoming.

Measures

The dependent variables of this study were body mass index (BMI), physical activity, food security, screen time, and hours of sleep. BMI was measured by using the caregiver's recollection of the child's height and weight and calculated by using the Centers for Disease Control and Prevention's definitions: underweight, less than the 5th percentile; healthy weight, 5th percentile to less than the 85th percentile; or overweight or obese, 85th percentile or higher (21). Based on the US Department of Health and Human Services' definition, the child was considered physically inactive if they did not participate in physical activity (eg, child exercises, sports) for at least 60 minutes every day (22). Participants were considered food secure if they could always afford nutritious meals, mildly food insecure if they could afford enough food but not always nutritious foods, and moderately to severely food insecure if they sometimes or often could not afford enough to eat. Screen time was categorized as less than 1 hour, 1 hour, 2 hours, 3

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hours, or 4 or more hours per day. Hours of sleep was categorized as getting the recommended hours of sleep or not on an average weeknight based on the child's age, which is 9 to 12 hours for children aged 10 to 12 years and 8 to 10 hours for adolescents aged 13 to 17 years.

The independent variables of this study consisted of variables related to the child and to the caregiver or household. The main independent variable of interest was rurality. The child variables were sex, age, race and ethnicity, and presence of special health care needs. The caregiver or household variables were the primary language of the household, highest level of educational attainment among adults in the household, family structure, and annual household income as a percentage of the federal poverty level (FPL). The presence of special health care needs was measured by using the Children with Special Health Care Needs Screener, a 5-item screening tool, based on the Maternal and Child Health Bureau definition and dichotomized as yes or no (23).

Statistical analysis

Descriptive statistics were produced as percentages for the independent variables and dependent variables levels and compared between children living in rural areas and those living in urban areas by using Pearson χ^2 and Cochran–Mantel–Haenszel tests. Multivariable logistic regression models examined the relationship between residence and the odds of being overweight or obese, physically inactive, food insecure, having more than 2 hours of screen time on the average day, and not meeting the recommended hours of sleep separately based on the independent variables (ie, sex, age, race and ethnicity, and presence of special health care needs). We used 2 hours or more of screen time as the cutoff because prior research recommended that children aged 5 to 17 years should be limited to no more than 2 hours of screen time per day (24,25). All analyses used the appropriate survey sampling weights, clusters, and strata provided by the NSCH. Data management and analysis were conducted in SAS version 9.4 (SAS Institute Inc). The University of South Carolina institutional review board deemed this study as exempt, nonhuman subjects research.

Results

Of the children in the sample, 11.4% resided in a rural area, three-quarters (75.7%) were aged 10 to 15 years, and most (51.1%) were male (Table 1). Less than half (46.8%) were non-Hispanic White, more than a quarter (28.4%) were Hispanic, more than one-tenth (13.9%) were non-Hispanic Black, and a little more than one-tenth (10.9%) were another or combination of non-Hispanic race and ethnicity. Just over one-quarter (26.0%) of children had special health care needs. Less than sixteen percent (15.9%) came from households that did not speak English as their primary language, and most (69.2%) came from households where one of the caregivers or parents had at least some college education. Most children (59.7%) came from households that had 2 married parents and came from households with an income above 99% of the FPL (80.9%). Children residing in rural areas were more likely than children in urban areas to be non-Hispanic White and to have family structures other than 2 parents or a single caregiver.

Children residing in rural areas had a higher likelihood of being overweight or obese (38.3%) than children residing in urban areas (32.1%; $P < .001$) but a lower likelihood of being physically inactive (80.0%) than children residing in urban areas (85.3%; $P < .001$) (Table 2). Children residing in rural areas had a higher likelihood of being food insecure (40.1%) than children residing in urban areas (31.7%; $P < .001$) but a lower likelihood of having more than 2 hours of screen time on an average day (55.2%) than children residing in urban areas (60.5%; $P = .001$). Children residing in rural areas had a higher likelihood of not sleeping for the recommended age-appropriate hours during an average weeknight (39.7%) than children residing in urban areas (35.5%; $P = .004$).

In multivariable logistic regression, rural children had higher odds of being overweight or obese (AOR = 1.36; 95% CI, 1.19–1.56), being food insecure (AOR = 1.27; 95% CI, 1.11–1.44), and not meeting the recommended hours of sleep (AOR = 1.23; 95% CI, 1.07–1.40) than urban children (Table 3). Rural children had lower odds of being physically inactive (AOR = 0.79; 95% CI, 0.70–0.90) and having more than 2 hours of screen time on an average day (AOR = 0.85; 95% CI, 0.75–0.96) than urban children.

Female children were more likely than male children to be physically inactive (AOR = 1.80; 95% CI, 1.61–2.01) but less likely to be overweight or obese (AOR = 0.70; 95% CI, 0.63–0.77) and to have more than 2 hours of screen time on an average day (AOR = 0.83; 95% CI, 0.76–0.91). Children aged 10 to 12 years were more likely than children aged 13 to 15 years to be overweight or obese (AOR = 1.31; 95% CI, 1.17–1.46) and not meet the recommended hours of sleep (AOR = 3.13; 95% CI, 2.81–3.49). Race and ethnicity also had a significant effect: Hispanic children, compared with non-Hispanic White children, had a higher likelihood of being overweight or obese (AOR = 1.72; 95% CI, 1.49–1.97), being physically inactive (AOR = 1.38; 95% CI, 1.16–1.64), being food insecure (AOR = 1.37; 95% CI, 1.18–1.59), and having more than 2 hours of screen time on an average day (AOR = 1.24; 95% CI, 1.08–1.41).

Children with special health care needs, compared with children without special health care needs, were more likely to be overweight or obese (AOR = 1.42; 95% CI, 1.28–1.58), be physically inactive (AOR = 1.43; 95% CI, 1.26–1.62), be food insecure (AOR = 1.60; 95% CI, 1.44–1.79), have more than 2 hours of

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screen time on an average day (AOR = 1.39; 95% CI, 1.25–1.53), and not meet the recommended hours of sleep (AOR = 1.21; 95% CI, 1.10–1.33). Children whose caregivers or parents had not attained an education higher than high school or a GED, compared with children whose caregivers or parents had at least some college education, had higher odds of being overweight or obese (AOR = 1.45; 95% CI, 1.27–1.65), being food insecure (AOR = 1.40; 95% CI, 1.23–1.59), and not meeting the recommended hours of sleep (AOR = 1.16; 95% CI, 1.03–1.32).

Poverty also had a significant effect. Compared with children from a household with an income of 400% or above the FPL, children from a household with an income between 0% and 99% of the FPL were more likely to be obese or overweight (AOR = 1.42; 95% CI, 1.21–1.67), be food insecure (AOR = 6.34; 95% CI, 5.35–7.52), and not meet the recommended hours of sleep (AOR = 1.27; 95% CI, 1.09–1.48), but they had lower odds of being physically inactive (AOR = 0.75; 95% CI, 0.63–0.90).

Discussion

This is the first study, to our knowledge, to examine geographic differences in the prevalence of overweight and obesity, food security, and obesogenic behaviors, specifically physical activity, sleep time, and screen time, using a national sample of children and adolescents. This research updates data on obesity, physical activity, and food insecurity and provides new information on sleep and screen time (12). Rural Healthy People 2030 recognized overweight and obesity as one of the top 5 priorities for improving rural health, while also ranking nutrition and physical activity among the top 10 focus areas (26). In both unadjusted and adjusted analyses, rural children were more likely than urban children to engage in physical activity and to have 2 hours or less screen time on an average day, which are positive behaviors; however, rural children were also more likely to experience food insecurity and to be overweight and obese, validating prior research (12). This study confirms earlier research using the NSCH finding that most children and adolescents in the US are meeting national guidelines for sleep, with fewer children and adolescents reaching the guidelines for physical activity and screen time (27).

A constellation of factors may contribute to more rural children being overweight or obese, compared with their urban counterparts, although we do not know the degree to which these are risk factors for obesity in a given setting. Rural children reside in poverty at much higher rates than urban children, with a much higher percentage of high-poverty counties in rural areas than urban areas (28). We found that children residing at or below the FPL had a higher likelihood than children residing 400% or above the FPL of being overweight or obese. Poverty has long been demonstrated to be associated with overweight or obesity status (29). The American Academy of Pediatrics has recommended screening for poverty and poverty-related social determinants of health, as these have been demonstrated to have negative consequences on child health and development (30).

Our results provide insight into the complexity of addressing childhood obesity. Previous research has consistently demonstrated a connection between obesogenic behaviors, such as physical inactivity and excessive screen time, with elevated BMI among children (31–33). However, our analysis suggests that the factors contributing to obesity may differ between urban and rural environments. In our analysis, compared with urban children, rural children had higher odds of being obese or overweight despite being less likely to be physically inactive or spend excessive time on screens. Although we found that rural children are more likely than urban children to be food insecure, a growing body of research suggests that food insecurity may result in increased consumption of ultra-processed calorie-dense foods (34,35). It is well established that energy imbalance — calorie intake exceeding expenditure — is the primary driver of weight gain and obesity (36). Although our data do not allow for precise measurement of calorie consumption, the energy imbalance model may help explain why, in our analysis, rural children were still more likely to be obese than urban children, despite being more physically active and having less screen time.

We found consistent sociodemographic disparities in our analyses. Compared with their non-Hispanic White counterparts, racial and ethnic minority and low-income children had significantly worse outcomes across obesogenic behaviors; they had higher odds of obesity, increased screen time, food insecurity, and physical inactivity. These disparities are in line with recent research that highlights the challenges faced by Black and Hispanic children, as well as those from lower-income households, who experience multiple barriers to achieving healthy behaviors and outcomes. These groups are more likely to live in environments with limited access to healthy food options, safe spaces for physical activity, and sufficient health care resources, which compound challenges in managing their weight and overall health (35).

The wide-ranging disparities observed in this study underscore the need for specialized interventions, particularly for rural children and for low-income children in racial and ethnic minority groups. Despite rural children being less likely to engage in excessive screen time or physical inactivity, they were still more likely to experience obesity, possibly due to factors like food insecurity and the consumption of calorie-dense, processed foods that are often

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more accessible and affordable in rural areas. The Institute of Medicine has recommended a need for multilevel interventions that focus on not just individual behaviors like physical activity and screen time but also broader environmental and systemic factors that influence children's health outcomes (36).

Strengths and limitations

Our study had multiple strengths. First, this is the most up-to-date analysis of rural and urban differences regarding weight, physical activity, food security, screen time, and hours of sleep. Second, the large sample size provided the statistical power to detect small differences. Third, the study used a national sample.

Our study also has limitations. The suppression of information from states with a population less than 100,000 children could leave some areas of the US underrepresented. Second, self-reported data present the potential for recall and social desirability bias, perhaps providing underestimates for health behaviors that could be perceived negatively. Third, the NSCH does not include children experiencing homelessness, so our analysis provides insight only into the health of children with a physical address.

Conclusions

These findings are instructive for community partners and program developers in creating policies and programs that allow for multitiered interventions to promote positive health behaviors to reduce overweight and obesity among all children. The findings from this study can be used to reduce disparities in health behaviors between rural and urban children. Further research is needed to elucidate information on dietary intake among rural children, for which our study dataset did not allow.

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Tables

Table 1. Characteristics of Children Aged 10 to 17 Years and Households, Overall (N = 35,963) and by Rural–Urban Residence, National Survey of Children's Health, 2021–2022

Characteristic	All	Rural	Urban	*P* value[a]
	%			
Overall	100.0	11.4	88.6	—
Child				
Sex				
Male	51.1	51.6	51.0	.65
Female	48.9	48.4	49.0	
Age, y				
10–12	37.4	38.1	37.3	.11
13–15	38.3	39.6	38.1	
16–17	24.4	22.2	24.7	
Race and ethnicity				
Hispanic	28.4	14.9	30.1	<.001
Non-Hispanic Black	13.9	10.3	14.3	
Non-Hispanic White	46.8	67.4	44.2	
Non-Hispanic Other[b]	10.9	7.5	11.4	
Has special health care needs	26.0	27.6	25.8	.14
Caregiver or household				
Primary language spoken in household is not English	15.9	7.3	17.1	<.001
Highest level of educational attainment of caregiver in the household				
High school diploma or less/GED	30.8	36.7	30.0	<.001
Some college or more	69.2	63.3	70.0	
Family structure				
2 Parents, currently married	59.7	58.2	59.9	.005
2 Parents, not currently married	5.4	5.1	5.4	
Single caregiver household	26.5	25.7	26.6	
Other	8.4	11.0	8.1	
Annual household income, % FPL				
0–99	19.1	23.1	18.6	<.001
100–199	20.8	25.8	20.2	
200–399	29.0	30.9	28.7	
≥400	31.1	20.2	32.5	

Abbreviations: — , does not apply; FPL, federal poverty level; GED, General Educational Development.
[a] *P* values were calculated to compare rural–urban differences in respondent characteristics by using Pearson χ^2 tests and Cochran–Mantel–Haenszel tests.
[b] Includes non-Hispanic Asian, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, multiracial, and biracial.

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Table 2. BMI Category, Physical Activity, Food Security, Screen Time, and Hours of Sleep, Children Aged 10 to 17 Years (N = 35,011), National Survey of Children's Health, 2021–2022

Characteristic	All	Rural	Urban	*P* value[b]
	%			
BMI[a]				
Underweight	7.1	5.5	7.3	<.001
Healthy weight	60.1	56.2	60.6	
Overweight or obese	32.8	38.3	32.1	
Physical activity				
Inactive (less than every day of the week)	84.7	80.0	85.3	<.001
Active (60 minutes of physical activity every day)	15.3	20.0	14.7	
Food security				
Food secure	67.3	59.9	68.3	<.001
Food insecurity	32.7	40.1	31.7	
Mild food insecurity	27.3	32.3	26.7	
Moderate to severe food insecurity	5.4	7.8	5.0	
Screen time, hours per day				
<1	4.4	6.0	4.3	.001
1	9.9	10.2	9.9	
2	25.8	28.6	25.4	
3	23.9	21.8	24.2	
≥4	35.9	33.4	36.3	
Child did not sleep for the recommended age-appropriate hours during an average weeknight	36.0	39.7	35.5	.004

Abbreviations: BMI, body mass index.
[a] BMI is calculated as 1) underweight (BMI <5th percentile), 2) healthy weight (5th percentile to <85th percentile), and 3) overweight or obese (≥85th percentile); categories established by the Centers for Disease Control and Prevention.
[b] *P* values were calculated to compare rural–urban differences in respondent characteristics by using Pearson χ^2 tests and Cochran–Mantel–Haenszel tests.

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Table 3. Prediction of Overweight or Obesity, Physical Inactivity, Food Insecurity, More Than 2 Hours of Screen Time, and Not Meeting Recommended Sleep Hours, Children Aged 10 to 17 Years (N = 34,452), by Rural–Urban Residence, National Survey of Children's Health, 2021–2022[a]

Characteristic	Model 1: overweight or obesity	Model 2: physical inactivity	Model 3: food insecurity	Model 4: >2 hours of screen time on an average day	Model 5: does not meet recommended hours of sleep
Rurality					
Rural	1.36 (1.19–1.56)[b]	0.79 (0.70–0.90)[b]	1.27 (1.11–1.44)[b]	0.85 (0.75–0.96)[b]	1.23 (1.07–1.40)[b]
Urban	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Child					
Sex					
Male	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Female	0.70 (0.63–0.77)[b]	1.80 (1.61–2.01)[b]	1.05 (0.94–1.16)	0.83 (0.76–0.91)[b]	1.00 (0.91–1.09)
Age, y					
10–12	1.31 (1.17–1.46)[b]	0.73 (0.64–0.83)[b]	0.95 (0.84–1.07)	0.55 (0.50–0.61)[b]	3.13 (2.81–3.49)[b]
13–15	1 [Reference]				
16–17	0.86 (0.76–0.97)[b]	1.00 (0.86–1.17)	0.99 (0.87–1.13)	1.18 (1.05–1.33)[b]	1.93 (1.71–2.17)[b]
Race and ethnicity					
Non-Hispanic White	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic Black	1.57 (1.36–1.82)[b]	1.34 (1.11–1.63)[b]	1.24 (1.06–1.45)[b]	1.40 (1.20–1.62)[b]	2.07 (1.79–2.38)[b]
Hispanic	1.72 (1.49–1.97)[b]	1.38 (1.16–1.64)[b]	1.37 (1.18–1.59)[b]	1.24 (1.08–1.41)[b]	1.13 (0.98–1.30)
Non-Hispanic Other[c]	1.07 (0.93–1.22)	1.23 (1.05–1.45)[b]	1.10 (0.95–1.27)	1.08 (0.95–1.22)	1.30 (1.15–1.47)[b]
Has special health care needs	1.42 (1.28–1.58)[b]	1.43 (1.26–1.62)[b]	1.60 (1.44–1.79)[b]	1.39 (1.25–1.53)[b]	1.21 (1.10–1.33)[b]
Caregiver or household					
Primary language spoken in household is not English	0.96 (0.79–1.16)	1.40 (1.09–1.79)[b]	0.72 (0.59–0.88)[b]	0.92 (0.77–1.11)	0.85 (0.71–1.03)
Highest level of educational attainment of caregiver in the household					
High school diploma or less/GED	1.45 (1.27–1.65)[b]	0.88 (0.76–1.01)	1.40 (1.23–1.59)[b]	0.99 (0.88–1.12)	1.16 (1.03–1.32)[b]
Some college or more	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Family structure					
2 Parents, currently married	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
2 Parents, not currently married	1.47 (1.18–1.84)[b]	0.95 (0.74–1.23)	1.57 (1.26–1.96)[b]	1.28 (1.03–1.60)[b]	1.30 (1.05–1.61)[b]
Single caregiver household	1.13 (1.00–1.28)	1.04 (0.89–1.21)	1.42 (1.25–1.60)[b]	1.22 (1.09–1.37)[b]	1.29 (1.15–1.45)[b]
Other	0.93 (0.77–1.12)	1.05 (0.85–1.31)	1.11 (0.88–1.39)	1.20 (0.98–1.46)	1.29 (1.07–1.57)[b]
Annual household income, % FPL					
0–99	1.42 (1.21–1.67)[b]	0.75 (0.63–0.90)[b]	6.34 (5.35–7.52)[b]	0.88 (0.76–1.03)	1.27 (1.09–1.48)[b]
100–199	1.58 (1.36–1.82)[b]	0.79 (0.66–0.93)[b]	6.18 (5.31–7.20)[b]	1.04 (0.91–1.19)	1.34 (1.17–1.54)[b]
200–399	1.38 (1.24–1.55)[b]	1.07 (0.94–1.22)	3.38 (2.97–3.86)[b]	1.02 (0.92–1.13)	1.14 (1.02–1.28)[b]
≥400	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]

Abbreviations: FPL, federal poverty level; GED, General Educational Development.
[a] All values are adjusted odds ratio (95% CI).
[b] Significant at $P < .05$.
[c] Includes non-Hispanic Asian, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, multiracial, and biracial.

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ESSAY

Our Schoolyard Infrastructure Just Isn't Cutting It: Play *Is* Public Health

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Introduction

Today, young people face increasing health challenges, many of which are due to declining opportunities for physical exercise and the interpersonal connections fostered by active play (1). Physical activity, which can prevent obesity and related chronic diseases, is at alarmingly low levels — only 16% of adolescents and 26% of children in the US meet the Healthy People 2030 physical activity guidelines (2). Simultaneously, young people are experiencing declining social connections, which support psychosocial health (3). Given that most people spend nearly 2 decades of their formative years in prekindergarten-to-grade 12 schools, these schools are critical settings for shaping lifelong health behaviors and attitudes. However, one of the most visible current challenges to promoting youth play for health is the condition of our school infrastructure (4), particularly outdoor spaces where active play most often occurs (5). Although infrastructure problems are related not only to schoolyards, these settings are particularly positioned to foster play, which has profound benefits for both acute and chronic health.

We, as physical activity and public health scholars, conduct community-based research, often in schools. When on a cool 101°F day (for Arizona!) we were collecting recess data at a local school, a new team member asked, "How is *that* ADA compliant?" pointing at a jutting asphalt lip outside the door to the multipurpose room, the access point from indoors to the schoolyard. The observation wasn't surprising. We repeatedly encounter outdated, inaccessible, weather-vulnerable schoolyards that fail to meet the federal guidelines and the needs of students and their communities.

Despite longstanding recognition of the importance of safe and engaging school environments for public health, infrastructure investments haven't kept pace. We highlight 2 persistent challenges from our experience that demonstrate how current schoolyard infrastructure fails to address accessibility and extreme weather conditions. We propose solutions to initiate community-driven change to play spaces to promote better health.

Accessibility

Accessibility for all children, particularly children with disabilities, is both a public health priority and a persistent challenge (6–8). The Americans with Disabilities Act (ADA) mandates that public schools adhere to accessibility guidelines, such as accessible routes to play components (eg, slides, swings) (9,10). However these requirements are the bare minimum, and many schoolyards nonetheless remain inaccessible to students with disabilities, preventing full participation in recess, physical education, and outdoor activities. For example, schools might have a rubberized pathway to a play structure, per ADA requirements (10), but the structure may remain inaccessible to students with mobility disabilities if the pathway ends with stairs. Even when play spaces include accessible pathways, few include appropriate surfacing, and fewer still have universal and adaptive play equipment (eg, wheelchair ramps, adapted mobility swings) (6). When students with mobility disabilities have to navigate uneven terrain and structural barriers, their ability to interact and play with peers is hindered.

Infrastructure challenges are even greater for some subgroups. In a prior study, we found playgrounds and playfields in schools in low-income neighborhoods were 3 to 7 times less accessible for students with disabilities than for those without disabilities (11). This is especially alarming given that people with disabilities are one of the largest marginalized groups worldwide (12). Inadequate funding and policy implementation are a few ways these inequities continue to increase gaps in accessibility and social connectivity.

Many schools simply lack financial resources to retrofit or renovate their infrastructure, especially those in low-income, high-need

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areas. The US spends approximately $18,500 per pupil from local, state, and federal funding, about 10% of which is partitioned for school renovations and alterations (13). Most schools make indoor renovations while neglecting outdoor areas; however, improving playgrounds and making them better accessible can enhance children's physical, social-emotional, and mental health — a necessary priority to overcome health disparities.

Resources are available to address infrastructure issues. For example, the ADA Checklist (14) and Child Community Health Inclusion Index (15) are useful tools to identify areas of need and can be used to seek funding and actualize change through state grants, local bonds, and community partnerships. Involving young people themselves in the co-creation of their playground redesign is also critical to creating universally enjoyable, suitable, and accessible spaces.

Developing schoolyards that accommodate students with disabilities is not just about meeting federal requirements. Our current infrastructure prioritizes play among students without disabilities while the physical, social-emotional, and mental health of students with disabilities suffers. This lack of attention demands that policymakers, schools, and communities reconceptualize how play-for-all looks. What child is excluded when school playgrounds are universally designed?

Extreme weather

A second major infrastructure shortfall is the failure to build schoolyards with consideration for regional weather. Extreme weather, including excessive heat, cold, flooding, and storms, has historically disrupted outdoor school-based play. As infrastructure ages (4) and these extremes either persist or become more intense or frequent (16), lack of supportive infrastructure hampers our ability to provide consistent, safe play spaces (5), compounding the decline in young people's play.

For example, in heat-prone regions like Arizona, where our research is based, schoolyards often lack adequate protection against extreme heat and sun exposure (17). Unshaded, heat-absorbing surfaces like asphalt, concrete, and metal, which are common in schoolyards, can be dangerously hot, and most elementary schools in the Southwest don't have indoor gymnasiums. Although research continues to explore the acute and chronic health problems associated with overexposure to extreme heat and sun, such as exertional heat stroke risk and skin cancer, we already know that prolonged exposure increases the risk of dehydration and heat-related illnesses, particularly among people with preexisting health conditions (18).

Problems related to extreme heat are pervasive. For example, in the fall semester of 2023 in Maricopa County, where more than 60% of the Arizona population resides, our own pilot data show that elementary schools canceled or modified 5 or more weeks of recess because of heat. As with accessibility concerns, schools in underserved communities often lack the financial capacity to implement heat-mitigation strategies such as shade structures, tree planting, or use of heat-resistant materials. These disparities contribute to systemic health inequities, because young people in low-income areas have limited access to safe spaces for physical activity and outdoor play even before adaptations for extreme weather can be considered (19).

But it's not all bad news. Awareness is growing, and communities are taking action. Schools, governments, and researchers are bolstering collaborative work toward weather-ready infrastructure that ensures year-round access to safe play opportunities. A promising example is the HeatReady Schools initiative, a part of the HeatReady Program developed by the City of Phoenix and researchers at Arizona State University to "identify, prepare for, mitigate, track, and respond to the negative impacts of schoolground heat" (20). Passive cooling strategies such as increasing shade through native tree canopy coverage and installing shade structures can significantly reduce heat risks (17). Given that many schools lack viable indoor play alternatives for inclement weather, such adaptations are critical to sustaining movement opportunities. Funding sources like state grants, environmental resilience programs, and local partnerships can help schools implement these improvements (eg, American Forests, Trees Matter, American Academy of Dermatology), but continued attention to the matter will be paramount as weather patterns and physical activity needs continue to shift.

Call to Action

Schoolyard infrastructure isn't just about aesthetics and convenience. It's a critical public health issue. Accessible and weather-ready schoolyards are only 2 examples highlighting the importance of ensuring that all students, regardless of ability or background, have safe opportunities to play. Although the obstacles are real, so are opportunities for action.

Change requires more than top-down mandates, although these are influential in their own right. School boards, where key infrastructure decisions are made, often lack momentum without significant community pressure. Grassroots movements are essential in generating momentum and co-creating. When schools, parents, local governments, and allies unite, they amplify the voices of those most affected — students, families, and community members who intimately understand their schools' needs. Collective effort can help initiate policies, secure funding, and push for necessary change. Local advocates can partner with school boards to con-

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duct accessibility audits, engage in weather resilience planning, and explore funding opportunities, keeping community needs at the forefront. By rallying together, communities can make meaningful improvements that benefit the entire community.

Researchers are also uniquely positioned to provide supporting evidence urging better schoolyard infrastructure. By conducting studies demonstrating long-term health, educational, and economic benefits, researchers can inform policymakers and communities about the true cost of inaction. Researchers can work with schools and communities to co-design and evaluate pilot programs, monitor the success of implemented strategies, assist with grant writing to secure funding, and co-develop best practices that prioritize health. Partnering with local advocates ensures data-driven, evidence-based support for grassroots movements, strengthening messaging that resonates with decision makers. Embedding research into communities ensures findings go beyond academic journals and drive effective change.

The cracks in schoolyard infrastructure have been widening for far too long, and we're now, unsurprisingly, seeing the consequences of poor planning, limited forward-thinking, and inaction. Neglecting these spaces perpetuates health inequities and limits opportunities for healthy behaviors. A well-designed, accessible, inclusive, and weather-ready schoolyard is not a luxury. It's the bare minimum in fostering a healthier generation. This issue remains central to our research, and we invite you to join us in ensuring that all students, at every school, in every community, can grow, learn, and play in environments that support lifelong health and resilience.

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ORIGINAL RESEARCH

Associations Between Screen Time Use and Health Outcomes Among US Teenagers

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Summary

What is known on this topic?

Teenagers with higher non-schoolwork daily screen time are more likely to experience a series of adverse health outcomes.

What is added by this report?

Teenagers with higher non-schoolwork screen use were more likely to engage in infrequent physical activity and to have weight concerns, depression symptoms, anxiety symptoms, infrequent social and emotional support, insufficient peer support, and an irregular sleep routine.

What are the implications for public health practice?

As the use of screens continues to increase and the ways teenagers interact with their screens diversify, timely estimates of screen use among teenagers are needed to better understand the effect of screens on the health of teenagers, as reported by teenagers.

Abstract

Introduction

Associations between screen time and health outcomes among teenagers are well established. However, most studies use parent-reported information, which may misrepresent the magnitude or nature of these associations. In addition, timely nationally representative estimates are needed to correspond with evolving screen use. This study aimed to address these gaps by using data from a nationally representative survey of teenagers.

Methods

Data came from the 2021–2023 National Health Interview Survey-Teen (NHIS-Teen), a follow-back web-based survey designed to collect health information directly from teenagers aged 12 to 17 years. NHIS-Teen provides a unique opportunity to assess teenagers' self-reported health in conjunction with a rich set of parent-reported covariates, including family income, from the National Health Interview Survey. This study examines associations between high daily non-schoolwork screen time, defined as 4 or more hours of daily screen time, and adverse health outcomes across the domains of physical activity, sleep, weight, mental health, and perceived support.

Results

Teenagers with higher non-schoolwork screen use were more likely to experience a series of adverse health outcomes, including infrequent physical activity, infrequent strength training, being infrequently well-rested, having an irregular sleep routine, weight concerns, depression symptoms, anxiety symptoms, infrequent social and emotional support, and insufficient peer support.

Conclusion

Results of this study include associations between high screen time and poor health among teenagers using self-reported data. Future work may further investigate these associations and their underlying mechanisms, including the content viewed on screens and the interactions taking place across screens.

Introduction

The availability of smartphones among teenagers (hereinafter, teens) has increased significantly in the past decade, with nearly all teens having access to smartphones or other internet-connected devices as of 2022 (1). Accompanying this increase in availability has been a notable increase in daily screen time, with an additional bump during the COVID-19 pandemic (2). High screen time can displace important health behaviors, such as physical activity and adequate sleep (3,4). Teens with limited physical activity and

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sleep are at risk for several negative mental health outcomes, including anxiety, depression, and poorer quality of life (5–9). The content viewed on screens may also have a direct impact on a teen's mental health (10). Previous research has found a connection between screen usage and poorer mental health, including perceptions of social connectedness (11,12).

With teens' continued screen use, combined with the influence of extensive technology, it remains critical to better understand the patterns of screen time use and health outcomes with timely, nationally representative data. To date, much of the nationally representative epidemiologic research examining the relationships between teen screen time and health has relied on parent report, with few, like the Youth Risk Behavior Survey (YRBS) (13), using teen self-report. Data obtained directly from teens may provide additional insights when compared with parent-reported data, particularly as related to the teen's internal world, mental health struggles, or perceived social and emotional supports (14). The National Health Interview Survey-Teen (NHIS-Teen) has the additional benefit of being linkable to family-level social determinants of health reported by their parents as part of the National Health Interview Survey (NHIS) (eg, family income, food security).

The objective of this study was to examine the relationship between daily screen time use among teens and several health outcomes, including physical activity, sleep, weight, mental health, and perceived support. Significant teen, family, and geographic differences in screen time use were identified in a recent study (15), including higher use among older teens, teens in metropolitan areas, and those from less educated families. These sociodemographic characteristics were controlled for to better understand the relationship between screen use and health-related outcomes. It was hypothesized that after adjustment for sociodemographic characteristics, teens with 4 or more hours of daily screen time would have poorer health outcomes than those with less than 4 hours of daily screen time across several health domains.

Methods

Data source

Data used in this report come from NHIS-Teen, a follow-back, self-administered, web-based survey of teens aged 12 to 17 years. Teens who participated in NHIS-Teen had parents who completed the NHIS Sample Child interview and provided permission for their teen to participate in NHIS-Teen. Topic areas in NHIS-Teen include doctor visits, sleep, physical activity and screen time, mental health, social and emotional supports, and experiences with bullying and discrimination. The parent permission rate for NHIS-Teen was 60.4% and the teen participation rate was 46.2%, resulting in an overall NHIS-Teen interview rate of 27.9%. Detailed information about NHIS-Teen, including survey methods, weighting, and the questionnaire is available at www.cdc.gov/nchs/nhis/teen.

A total of 1,958 teens completed NHIS-Teen between July 2021 and December 2023. Teens with missing data for screen time were excluded, resulting in a total analytic sample of 1,952.

Measures

Screen time

Daily screen time was measured using the question, "On most weekdays, how many hours do you spend a day in front of a TV, computer, cell phone, or other electronic device, watching programs, playing games, accessing the internet, or using social media?" Teens were given the options of "less than 1 hour," "1 hour," "2 hours," "3 hours," and "4 or more hours." Teens were told as part of the question's instructional text to exclude time spent doing schoolwork. For this analysis, teens reporting "4 or more hours" were categorized as having high daily screen time. This was selected to effectively cut the sample in half while categorizing the highest screen time users.

Physical activity

Infrequent physical activity. Teens were asked, "In a typical week during the school year, how often do you exercise, play a sport, or participate in physical activity for at least 60 minutes a day?" — mirrored after the Centers for Disease Control and Prevention's *Physical Activity Guidelines for Americans, 2nd edition* (16). Response options were "never," "some days," "most days," and "every day." Teens were considered to have infrequent physical activity if they answered "never" or "some days."

Infrequent muscle strengthening. Teens were asked, "In a typical week during the school year, how often do you do exercises to strengthen or tone your muscles, such as sit-ups, push-ups, or weightlifting?" Response options were "never," "some days," "most days," and "every day." Teens were considered to have infrequent muscle strengthening if they answered "never."

Sleep

Infrequently well-rested. Teens were asked, "In a typical week during the school year, how often do you wake up well-rested?" Response options were "never," "some days," "most days," and "every day." Teens who selected "never" and "some days" were considered to be infrequently well-rested.

Irregular sleep routine. Teens were also asked whether they had a regular bedtime ("In a typical week during the school year, on nights you have school the next day, how often do you go to bed at

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the same time?") and waketime ("In a typical week during the school year, on school days, how often do you wake up at the same time?") Teens were given the same response options of "never," "some days," "most days," and "every day" for each question, and teens who did not answer "most days" and "every day" for both questions were considered to have an irregular sleep routine.

Weight concern

Teens were asked "Are you concerned about your weight?" with the response options of "yes, it's too high," "yes, it's too low," and "no." Teens who said their weight was too high or too low were considered to have weight concerns.

Mental health

Anxiety symptoms. NHIS-Teen included the Generalized Anxiety Disorder-2 (GAD-2) scale (17) which consists of 2 questions: "Over the last 2 weeks, how often have you been bothered by feeling nervous, anxious, or on edge?" and "Over the last 2 weeks, how often have you been bothered by not being able to stop or control worrying?" Response options included "not at all," "several days," "more than half the days," and "nearly every day," with the responses scored 0, 1, 2, or 3, respectively. Teens were required to answer both questions to have a total score calculated, and teens who scored 3 or more on the combined questions were considered to have anxiety symptoms per GAD-2 scoring guidelines.

Depression symptoms. Teens also completed the Patient Health Questionnaire-2 (PHQ-2) scale (18). This scale also consisted of 2 questions: "Over the last 2 weeks, how often have you been bothered by having little interest or pleasure in doing things?" and "Over the last 2 weeks, how often have you been bothered by feeling down, depressed, or hopeless?" Like the GAD-2, response options were "not at all," "several days," "more than half the days," and "nearly every day," with the same assigned value per response. Teens were required to answer both questions to have a total score calculated, and teens who scored 3 or more on the combined questions were considered to have depression symptoms per PHQ-2 scoring guidelines.

Perceived support

Insufficient peer support. Teens were asked 2 questions about the peer support in their lives: "How much can you rely on your friends for help if you have a serious problem?" and "How much can you open up to your friends if you need to talk about your worries?" Both questions had the response options of "a lot," "some," "a little," and "not at all." Teens who did not answer "a lot" or "some" to both questions were considered to have insufficient peer support. Teens who did not answer both questions were not included in the outcome.

Infrequent social and emotional support. Teens were asked "How often do you get the social and emotional support you need?" with the response options of "always," "usually," "sometimes," "rarely," and "never." Teens who answered "sometimes," "rarely," or "never" were considered to have infrequent social and emotional support.

Sociodemographic characteristics were reported by parents as part of the NHIS Sample Child interview and included teen sex; age (12–14 y, 15–17 y); race and Hispanic origin (non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Hispanic); urbanization level (metropolitan area [large central, large fringe, medium, and small] or nonmetropolitan area [micropolitan and noncore counties]) (19); highest level of education of any resident parent (some college or associate's degree or less or bachelor's degree or higher); and family income as a percentage of federal poverty level (less than 200%, 200% or more) (NHIS income data includes imputation when missing) (20–22). As reported elsewhere (15) based on analyses of the same dataset, older teens, non-Hispanic Black teens, and teens with less educated parents were more likely to have 4 or more hours of daily screen time. No differences were seen by sex, family income, or urbanization level. The supplemental table (Appendix) explores the percentage distribution of sociodemographic characteristics by screen time among teens, comparing those with less than 4 hours and those with 4 or more hours of daily screen time.

Statistical analysis

The prevalence of various health outcomes was examined comparing teens with 4 or more hours of daily screen time to those with less than 4 hours of daily screen time. Differences between groups were calculated using bivariate Poisson regressions (calculated as prevalence ratios); multivariable Poisson regressions were conducted to determine whether these differences remained after adjustment for sociodemographic characteristics including teen age, sex, race and Hispanic origin, urbanization level, highest educated parent, and family income. A sensitivity analysis included adding interactions between screen time and sex and screen time and age to the final models.

All estimates were weighted, and confidence intervals accounted for the complex sample design of the NHIS-Teen (23) using Stata SE version 17.0 (StataCorp LLC), thereby allowing for nationally representative estimates, accounting for nonresponse both for parent permission and teen participation. All estimates in this report met National Center for Health Statistics data presentation stand-

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ards for proportions (24). Missingness on health outcomes of interest ranged from 0.1% to 3.8%.

Results

Approximately half (50.4%) of all teens had 4 or more hours of daily screen time (Table 1). Teens with high daily screen time were more likely to have infrequent physical activity (45.6% vs 32.1%) and infrequent strength training (23.0% vs 13.3%). In addition, they were more likely to be infrequently well-rested (59.9% vs 40.1%) and to have an irregular sleep routine (49.2% vs 29.2%), as well as more likely to have weight concerns (37.8% vs 25.3%) (Figure 1).

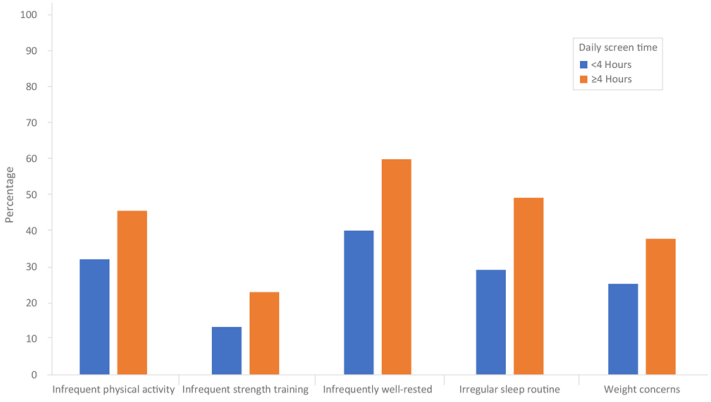


Figure 1. Prevalence of physical activity, sleep, and weight outcomes, by daily screen time use, United States, National Health Interview Survey-Teen, July 2021–December 2023. All values differed significantly from teens with less than 4 hours of daily screen time ($P < .05$).

Teens with high daily screen time were more likely to have depression symptoms (25.9% vs 9.5%) and anxiety symptoms (27.1% vs 12.3%) in the past 2 weeks compared with teens without high daily screen time (Figure 2). They were also more likely to report having infrequent social and emotional support (48.6% vs 35.1%) and insufficient peer support (37.0% vs 30.4%).

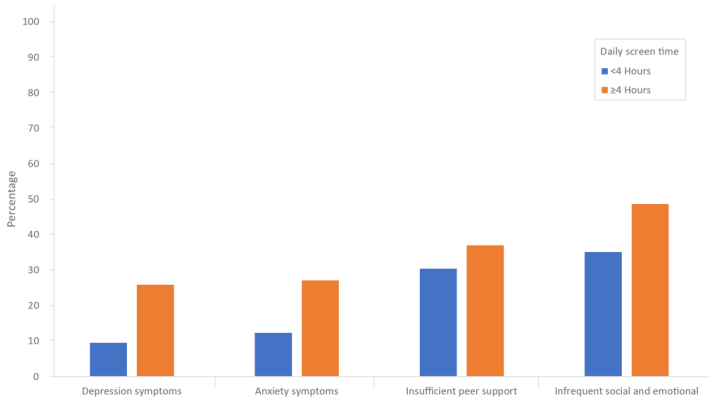


Figure 2. Prevalence of mental health and perceived support outcomes, by daily screen time use, United States, National Health Interview Survey-Teen, July 2021–December 2023. All values differed significantly from teens with less than 4 hours of daily screen time ($P < .05$).

In all adjusted models, with one exception, high daily screen time continued to be associated with poorer health outcomes. The adjusted analysis showed that teens with high daily screen time remained more likely to have infrequent physical activity (adjusted prevalence ratio [APR] = 1.33; 95% CI, 1.14–1.54) and infrequent strength training (APR = 1.64; 95% CI, 1.27–2.11) (Table 2). They were also more likely to be infrequently well-rested (APR = 1.45; 95% CI, 1.30–1.63) and to have weight concerns (APR = 1.42; 95% CI, 1.20–1.69), depression symptoms (APR = 2.51; 95% CI, 1.89–3.35), anxiety symptoms (APR = 2.12; 95% CI, 1.67–2.71), infrequent social and emotional support (APR = 1.29; 95% CI, 1.13–1.47), and an irregular sleep routine (APR = 1.58; 95% CI, 1.36–1.83). Although teens with high daily screen time were more likely to have insufficient peer support in unadjusted models (PR = 1.22; 95% CI, 1.05–1.42), this association was attenuated following adjustment for covariates (APR = 1.16; 95% CI, 0.99–1.35). In a sensitivity analysis, an interaction between 4 or more hours of screen time and being male was found for weight concerns (APR = 0.64; 95% CI, 0.45–0.91) and 4 or more hours of screen time and being aged 12 to 14 years for being infrequently well-rested (APR = 1.33; 95% CI, 1.06–1.67).

Discussion

High daily screen time was prevalent with over half of all teens having 4 or more hours of daily screen time. High screen use was consistently associated with poorer health outcomes among teens, aligning with much of the current literature. High screen time has been associated with lower rates of exercise and strength training, as well as an increased obesity risk and higher adiposity measures (25,26). High screen time has also been associated with later bedtimes, insufficient sleep duration, reduced sleep efficiency, insom-

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nia symptoms, and excessive daytime sleepiness (27,28). Use of screens not only delays the time teens go to bed and fall asleep, but can also affect their circadian timing, sleep physiology, and alertness due to the light emitted from the screens themselves (29).

Screens can be a contributor to poorer mental health, but they also may have some value as coping mechanisms for teens who are experiencing feelings of isolation (30). Nonetheless, teens with high levels of daily screen time were more likely to report both anxiety and depression symptoms, even after adjustment for covariates, mirroring findings in recent years (13,31). Although teens have indicated that daily screen time can be used for positive purposes, like social check-ins, other uses such as accessing social media daily still have the potential to lead to social isolation and fear of missing out on activities with peers (32), with some teens acknowledging the addictive qualities of social media consumption (33). The association between screen time and social isolation and loneliness has been established in several studies (34). This study is the first to our knowledge to examine whether perceived social and emotional supports are less frequent among teens with high daily screen time. However, these findings are in parallel with previous research indicating that high social media use may be a barrier to in-person communication with friends and family (35).

Additional findings highlight associations between high screen time use and weight concerns among teens. Of note, this study did not incorporate information about teens' actual weight but relied only on concerns about their own weight. However, several observational studies have documented that increased daily screen time is associated with greater body dissatisfaction and eating disorder symptoms, body dysmorphia, including a fear of weight gain, self-worth tied to weight, and weight-changing behaviors (36).

Strengths and limitations

This study has several strengths. NHIS-Teen is a large and timely nationally representative survey of teens, providing sufficient sample size to explore prevalence among various subgroups. NHIS-Teen is also supplemented by data on sociodemographic characteristics provided by parents as part of the NHIS, such as health insurance and family income, which may be inaccurately reported by teens. Estimates of daily screen time from NHIS-Teen were considerably higher than those reported by parents as part of the National Survey of Children's Health (NSCH) during the same period (37). The use of teen self-reported data can lead to a more accurate estimate of screen time use (38).

Despite these strengths, some limitations should be considered when reviewing these findings. Similar to other studies like the NSCH and YRBS, the cross-sectional nature of NHIS-Teen prevents the ability to establish causality or directionality when discussing the associations between screen time and health outcomes. Future research would benefit from a longitudinal design that could further investigate causal mechanisms. Types, content, and quality of screen usage were not accounted for and could be important contextual factors of screen time use and their impact on health, including the potential beneficial use of some screen use (39). Further, subjective measures of reported screen time and health outcomes were used instead of objective time-collecting indicators. As such, validating teen responses was not possible. Finally, despite the use of a web-based data collection tool, teens may be deliberately inaccurate in their answers due to social desirability (40) and expectations for how much screen time they should report. However, NHIS-Teen implements several quality control measures such as removing teenagers from the final data set who skipped a significant number of questions, sped through the survey, or provided nonsensical answers (resulting in approximately 0.5% of the original sample being removed).

Implications

The American Academy of Pediatrics (AAP) rescinded their screen time guidelines in 2016 as use of screens became ubiquitous and the variety of ways to engage with screens dramatically increased; in their place was the recommendation to develop a family media plan with goals to create an appropriate balance for media time and establish consistent rules about screen use and boundaries for accessing content (41). These include parental strategies for managing their teen's screen time as well as encouraging offline activities and hobbies. The AAP has also highlighted the role of pediatricians in promoting healthy and active living by helping teens balance media use, healthy eating, and exercise (42). Future surveys dedicated to teen health may benefit from added questions about whether family rules exist about screen use and whether conversations have occurred between teens and their doctors about healthy screen use, including the time spent on screens, devices, location of use, content viewed, and any interactions that may be occurring. They may also attempt to better understand the relationship between sleep, physical activity, and sedentary behaviors over a typical teen's day (43).

Conclusions

Findings from this study highlight associations between increased screen time and a variety of poorer health outcomes spanning across multiple domains, including mental health and perceived support.

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Tables

Table 1. Percentage of Teenagers With ≥4 Hours of Daily Screentime Use (N = 1,952), by Study Sample Characteristic, National Health Interview Survey-Teen, United States, July 2021–December 2023[a]

Characteristic	% (95% CI)	SE	Prevalence ratio (95% CI)
Overall	50.4 (47.6–53.2)	1.40	—
Age, y			
12–14	45.6 (41.5–49.8)	2.07	0.83 (0.74–0.93)
15–17	55.0 (51.2–58.9)	1.93	1 [Reference]
Sex			
Male	48.3 (44.4–52.2)	1.95	0.92 (0.82–1.02)
Female	52.5 (48.5–56.5)	2.00	1 [Reference]
Race and Hispanic origin			
Non-Hispanic Asian	43.5 (33.4–53.9)	5.03	0.91 (0.71–1.56)
Non-Hispanic Black	60.4 (51.4–68.9)	4.30	1.26 (1.07–1.49)
Non-Hispanic White	47.9 (44.0–51.8)	1.94	1 [Reference]
Hispanic	52.8 (46.6–58.8)	3.03	1.10 (0.96–1.27)
Urbanization level			
Metropolitan	51.4 (48.5–54.4)	1.49	1.19 (0.99–1.42)
Nonmetropolitan	43.3 (35.8–51.0)	3.75	1 [Reference]
Highest level of parents' education			
Some college or less	55.0 (50.6–59.3)	2.17	1.21 (1.09–1.35)
College degree or higher	45.2 (41.7–48.7)	1.76	1 [Reference]
Family income as a percentage of the federal poverty level			
<200%	51.7 (46.2–57.3)	2.77	1.04 (0.92–1.18)
≥200%	49.6 (46.3–52.9)	1.65	1 [Reference]

[a] All estimates are weighted to the national population.

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Table 2. Logistic Regression Models Presenting Associations Between ≥4 Hours of Screen Time and Health Outcomes Among Teenagers, National Health Interview Survey-Teen, United States, July 2021–December 2023[a]

Overall sample	Model 1: PR (95% CI)	Model 2: APR (95% CI)
Physical activity		
Infrequent physical activity	1.42 (1.22–1.66)[b]	1.33 (1.14–1.54)[b]
Infrequent strength training	1.73 (1.35–2.22)[b]	1.64 (1.27–2.11)[b]
Sleep		
Infrequently well-rested	1.49 (1.32–1.68)[b]	1.45 (1.30–1.63)[b]
Irregular sleep routine	1.67 (1.44–1.93)[b]	1.58 (1.36–1.83)[b]
Weight		
Weight concerns	1.49 (1.26–1.77)[b]	1.42 (1.20–1.69)[b]
Mental health		
Depression symptoms	2.74 (2.04–3.67)[b]	2.51 (1.89–3.35)[b]
Anxiety symptoms	2.21 (1.72–2.82)[b]	2.12 (1.67–2.71)[b]
Perceived support		
Insufficient peer support	1.22 (1.05–1.42)[c]	1.16 (0.99–1.35)
Infrequent social and emotional support	1.38 (1.20–1.59)[b]	1.29 (1.13–1.47)[b]

Abbreviations: APR, adjusted prevalence ratio; PR, prevalence ratio.
[a] All analyses used NHIS-Teen weighting. Model 2 was adjusted for parent-reported teen age (12–14 y, 15–17 y), sex (male, female), race or Hispanic origin (non-Hispanic Asian, non-Hispanic other/multiracial, non-Hispanic Black, non-Hispanic White, Hispanic), urbanization level (metropolitan, nonmetropolitan), parental education (some college or less, college degree or higher), and family income as a percentage of the federal poverty level (<200%, ≥200%). The reference group for all prevalence ratios was less than 4 hours of screen time.
[b] $P < .001$.
[c] $P = .01$.

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Appendix. Distribution of Sociodemographic Characteristics, by Daily Screen Time, United States, National Health Interview Survey-Teen, July 2021–December 2023[a]

Sociodemographic characteristic	≥4 Hours, % (95% CI) (n = 987)	<4 hours, % (95% CI) (n = 965)
Overall	50.4 (47.6–53.2)	49.6 (46.8–52.4)
Age, y		
12–14	44.9 (41.0–48.8)	54.3 (50.1–58.4)
15–17	55.1 (51.2–59.0)	45.7 (41.6–49.9)
Sex		
Male	49.2 (45.1–53.4)	53.5 (49.5–57.4)
Female	50.8 (46.6–54.9)	46.5 (42.6–50.5)
Race and Hispanic origin		
Non-Hispanic Asian	3.8 (2.7–5.2)	5.1 (3.8–6.6)
Non-Hispanic Black	15.0 (11.9–18.5)	10.0 (7.3–13.2)
Non-Hispanic White	48.5 (44.5–52.5)	53.6 (49.5–57.6)
Hispanic	27.8 (24.1–31.7)	25.2 (21.4–29.3)
Non-Hispanic Other/multiracial	4.9 (3.6–6.6)	6.2 (4.2–8.7)
Urbanization level		
Metropolitan	88.8 (85.2–91.7)	85.1 (80.9–88.7)
Nonmetropolitan	11.2 (8.3–14.8)	14.9 (11.3–19.1)
Highest level of parents' education		
Some college or less	57.0 (53.2–60.7)	47.2 (43.0–51.4)
College degree or higher	43.0 (39.3–46.8)	52.8 (48.6–57.0)
Family income as a percentage of the federal poverty level		
<200%	36.6 (32.6–40.7)	34.7 (30.4–39.2)
≥200%	63.4 (59.3–67.4)	65.3 (60.8–69.6)

[a] All estimates are weighted to the national population.

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RESEARCH BRIEF

Maintenance of Sugar-Sweetened Beverage Behaviors Among Adolescents and Their Caregivers: A Cluster Randomized Controlled Trial

Annie Reid, MPH, RDN[1]; Wen You, PhD[2]; Theresa Markwalter, MPH[1]; Kathleen Porter, PhD, RDN[1]; Donna-Jean Brock, MS[1]; Philip Chow, PhD[3]; Lee Ritterband, PhD[3]; Jamie Zoellner, PhD, RDN[1]

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PEER REVIEWED

Summary

What is already known on this topic?

Behavior-change interventions to reduce intake of sugar-sweetened beverages (SSBs) have shown promising short-term outcomes, but little is known about the long-term maintenance effects of such interventions.

What is added by this report?

We report the 19-month maintenance effects of Kids SIP*smart*ER, a 6-month, multilevel, behavioral intervention that included classroom-based lessons for middle school students and a short-message-service (SMS) strategy for caregivers. Kids SIP*smart*ER led to significant reductions in SSB intake in students but not caregivers.

What are the implications for public health practice?

Study findings highlight the effect of Kids SIP*smart*ER in achieving sustained SSB reductions among rural students in Central Appalachia. More research is needed to explore how SMS interventions can sustain SSB reductions among caregivers.

Abstract

The intake of sugar-sweetened beverages (SSBs) is a public health concern. Evidence-based behavior-change interventions can facilitate reductions in intake. Understanding maintenance of reductions after an initial intervention period is essential. In a cluster randomized controlled trial of 12 middle schools in Appalachia, we examined the 19-month maintenance effects of a 6-month school-based SSB reduction intervention tailored for middle school students and caregivers and demonstrated to be effective. Relative to their control counterparts, intervention students maintained significant reductions in SSB intake, while intervention caregivers did not show sustained effects. This study offers valuable insights into the long-term effect of school-based behavioral interventions designed to reduce intake of SSBs.

Objective

Sugar-sweetened beverages (SSBs) are a public health concern in the US; they have well-documented associations with many chronic health conditions (1). SSB intake is disproportionately high in Central Appalachia, where average intake is double the national average for adolescents and adults (2). Evidence-based SSB interventions are essential for addressing disparities in medically underserved rural areas, including interventions that can facilitate sustained behavior change.

The maintenance period of behavior-change interventions refers to outcomes observed 6 months or more after the last intervention contact (3). The literature examining the maintenance effects of behavior-change interventions (4), including the SSB-intake behaviors of adolescents, is limited. In 4 systematic reviews examining SSB intake, only 4 randomized controlled trials focused on middle school students and also included a maintenance period. Although these studies showed short-term reductions in SSB intake, none found improvements at long-term follow-up (5–8). Similarly, short-message-service (SMS) interventions also demonstrated positive outcomes, but none described long-term maintenance effects (9).

The Kids SIP*smart*ER intervention, the focus of this research, effectively decreased student and caregiver SSB intake at 7-month follow-up (2). The objective of this study was to test the hypothesis that improvements in SSB intake at 7 months among intervention participants would be sustained at 19 months.

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Methods

The Kids SIP*smart*ER cluster randomized controlled trial occurred from the 2018–2019 through the 2021–2022 academic school years in 12 middle schools in southwestern Virginia and West Virginia. Schools were randomized to the intervention or a delayed control. Protocol details are described elsewhere (10). All 7th grade students and 1 caregiver per student were eligible to participate, regardless of SSB intake. Students who assented to participate and whose parents consented for their student to participate were enrolled in the intervention and control; students completed a baseline assessment. All caregivers who enrolled in the intervention and control consented to participate and completed a baseline assessment. Enrolled students received a nominal prize, and enrolled caregivers received up to $30 in gift cards for survey completion. The study was approved by the University of Virginia Institutional Review Board.

Kids SIP*smart*ER was a multilevel, 6-month behavioral intervention targeting SSB intake among 7th-grade students and their caregivers. Students received 12 classroom-based lessons focused on skill-based health literacy concepts. A 2-way SMS strategy engaged caregivers in role modeling SSB behaviors, improving the home environment, and supporting rules and practices. Content was guided by the Theory of Planned Behavior and health literacy concepts. Maintenance data were collected at 19 months using the same survey used at baseline and 7-month follow-up. Participants self-reported demographic characteristics. SSB intake during the past month was assessed by using the validated Beverage Intake Questionnaire (11). Due to COVID-19 disruptions, student and caregiver paper-and-pencil surveys transitioned to an online format. Students completed surveys during a regular classroom period in 11 of 12 schools; 1 school conducted online surveys only due to closure.

We calculated changes in SSB intake in ounces per day from baseline to 19 months. Participants with change scores equal to or greater than twice the IQR were considered outliers and excluded from analysis (2). The IQR is good for identifying outliers, especially in skewed and asymmetric distributions (12). Our analyses of 19-month maintenance were identical to analyses at 7-month follow-up, whereby we used modified 2-part models with fixed effects to estimate between-group treatment effects over time for SSB outcomes (2). For the 19-month analyses, because of COVID-19 disruptions and concerns about nonrandom missing data, we used data only from participants who were present at follow-up, rather than an intention-to-treat approach, which was used at 7-month follow-up.

Results

Of the 526 students and 220 caregivers with complete data at 7-month follow-up, 324 (62%) students and 146 (66%) caregivers completed the maintenance assessment at 19 months (Figure 1 and Supplemental Table). The exclusion of outliers (15 [3%] students and 13 [6%] caregivers) resulted in 309 students and 133 caregivers for the analysis at 19 months. Of the 309 students who completed all 3 assessments, the mean age was 12.7 years, 54% were girls, 87% were White, and 48% had a healthy body mass index (Table).

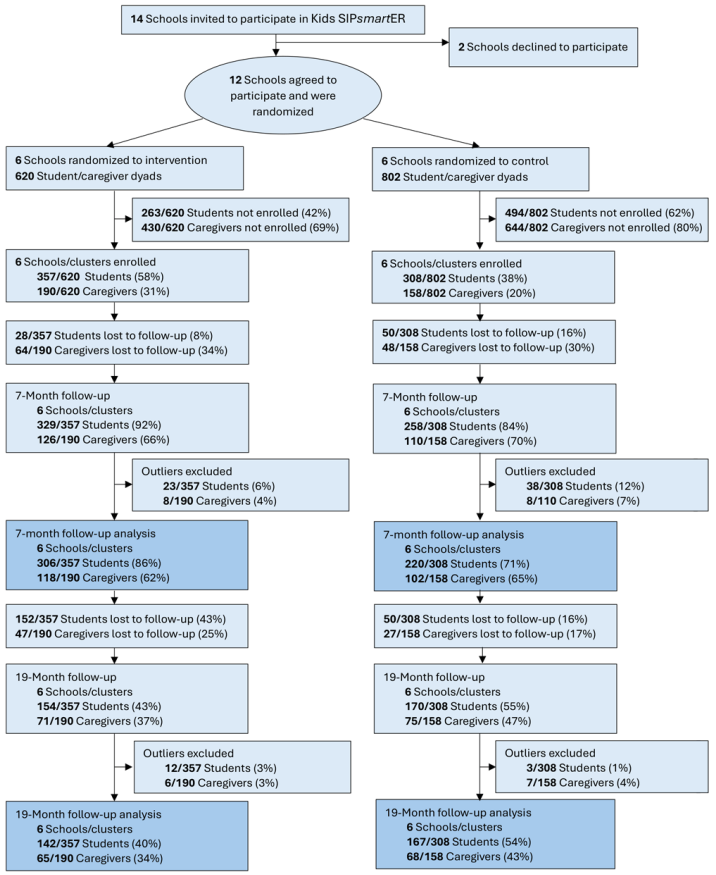


Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram for Kids SIP*smart*ER, an intervention designed to decrease intake of sugar-sweetened beverages among middle school students and their caregivers in southwestern Virginia and West Virginia, 2018–2022.

During the 6-month intervention, students who received the Kids SIP*smart*ER intervention significantly reduced their SSB intake by −6.1 ounces per day (95% CI, −10.1 to −1.9; $P = .004$), while control-group students reduced intake by −2.0 ounces per day (95% CI, −3.6 to −0.4; $P = .01$) (Figure 2). A relative difference of

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−4.0 ounces per day (95% CI, −8.4 to 0.3; $P = .07$; effect size [ES] = 0.22) favored the intervention group. In the 19-month period, intervention students decreased SSB intake by −9.4 ounces per day (95% CI, −13.6 to −5.1; $P < .001$), compared with a −4.0 ounce-per-day reduction in the control group (95% CI, −6.9 to −1.2; $P = .005$). Overall, between baseline and 19 months, we found a significant relative difference of −5.3 ounces per day (95% CI, −10.4 to −0.2; $P = .04$; ES = 0.24), indicating that intervention students maintained their SSB improvements at 19 months.

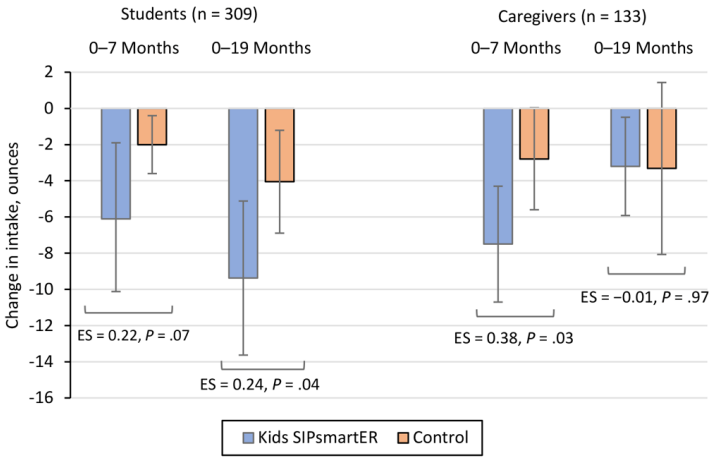


Figure 2. Changes in intake of sugar-sweetened beverages, in ounces, by randomized treatment condition, among students and caregivers in Kids SIP*smart*ER, an intervention designed to decrease intake among middle school students and their caregivers in southwestern Virginia and West Virginia, 2018–2022. Abbreviation: ES, effect size.

During the 6-month intervention period, caregivers in the intervention group significantly reduced their SSB intake by −7.5 ounces per day (95% CI, −10.7 to −4.3; $P < .001$), while caregivers in the control group reduced intake by −2.8 ounces per day (95% CI, −5.6 to 0.03; $P = .05$) (Figure 2). A relative difference of −4.7 ounces per day (95% CI, −8.9 to −0.3; $P = .03$; ES = 0.38) favored intervention caregivers over those in the control group. In the 19-month period, intervention caregivers reduced SSB intake by −3.2 ounces per day (95% CI, −5.9 to −0.5; $P = .02$), while caregivers in the control group decreased intake by −3.3 ounces per day (95% CI, −8.1 to 1.4; $P = .17$). The nonsignificant between-group effect ($P = .97$; ES = −0.01) indicates that intervention caregivers did not maintain their SSB improvements at 19 months.

Discussion

Relative to students in the control group, students in the Kids SIP*smart*ER intervention maintained improved SSB-intake behaviors at 19 months. To our knowledge, this is the first behavioral intervention to show maintenance of SSB-intake behaviors among adolescents beyond the initial behavioral intervention period (5–8). While the overall between-group ES was relatively small (ie, 0.24), our intervention was intended for all adolescents regardless of baseline SSB intake. From this perspective, primary prevention interventions with small effects can have important public health implications. The sustained 9-ounce SSB reduction among adolescents receiving the Kids SIP*smart*ER intervention has clinical relevance, as epidemiologic studies consistently link each 8-to-12–ounce decrease in SSB intake to health benefits (1).

Contrary to our hypothesis, the significant effects among intervention caregivers enrolled in the SMS intervention at 7-month follow-up were not sustained at 19 months. This is a key contribution to the field, because little is known about the maintenance effects of SMS interventions. In a meta-analysis of 35 SMS studies, only 7 collected data after a no-intervention maintenance period (9). The pooled maintenance effect from these studies was small but significant (Cohen $d = 0.17$; $P = .02$); however, none focused on nutrition. Our contrasting findings highlight the need to better understand strategies for sustaining behavior change, including changes in SSB intake, in "low-touch" interventions (ie, interventions, such as SMS interventions, that maximize the use of technology while minimizing direct human interaction to engage audiences).

Our study has 2 key limitations. First, the amount of missing data, largely due to COVID-19, should be considered when interpreting findings. Notably, relative to the 7-month postintervention period in this maintenance sample, the primary outcomes of the 7-month postintervention period, which included a larger sample and used an intention-to-treat analysis, revealed some differences in effect sizes for students (ES = 0.35 vs 0.22) and caregivers (ES = 0.33 vs 0.38) (10). Second, our study may lack generalizability beyond the unique rural Central Appalachian region. Despite these limitations, our study's strengths include a rigorous cluster randomized controlled trial design, use of validated SSB measures, and a focus on the rural medically underserved Appalachian region.

Our findings demonstrate that Kids SIP*smart*ER — a school-based curriculum grounded in the Theory of Planned Behavior and health literacy — effectively maintains SSB reductions among adolescents in medically underserved rural areas. Given that even modest reductions in SSB intake are linked to health improvements, this study highlights the potential effect of disseminating Kids SIP*smart*ER to achieve sustained reductions in SSB intake among rural students. However, caregivers did not maintain reductions in SSB intake, underscoring the need for strategies to ensure lasting behavior change in low-touch SMS interventions or other scalable approaches.

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Table

Table. Baseline Demographic Characteristics of Enrolled Students and Caregivers Who Completed Baseline, 7-Month, and 19-Month Assessments, Overall and by Randomized Condition, Kids SIP*smart*ER

Characteristic	Overall	By randomized condition	
		Kids SIP*smart*ER[a]	Control
Students			
Total no.	309	142	167
Age, mean (SD), y	12.7 (0.5)	12.7 (0.6)	12.6 (0.4)
Sex, no. (%)			
Female	168 (54)	87 (61)	81 (49)
Male	135 (44)	53 (37)	82 (49)
Other or unknown	6 (2)	2 (1)	4 (2)
Race, no. (%)			
Black	16 (5)	6 (4)	10 (6)
White	268 (87)	124 (87)	144 (86)
Other or unknown	25 (8)	12 (8)	13 (8)
Hispanic ethnicity, no. (%)	10 (3)	4 (3)	6 (4)
BMI[b] *z*-score, mean (SD)	0.9 (1.1)	0.9 (1.1)	0.9 (1.0)
BMI[b] percentile, mean (SD)	72.9 (26.8)	72.4 (28.2)	73.3 (25.6)
BMI[b] categories, no. (%)			
Underweight (BMI <5th percentile)	6 (2)	3 (2)	3 (2)
Healthy weight (BMI 5th to <85th percentile)	149 (48)	70 (49)	79 (47)
Overweight (BMI 85th to <95th percentile)	54 (17)	23 (16)	31 (19)
Obesity (BMI 95th to <99th percentile)	59 (19)	31 (22)	28 (17)
Severe obesity (BMI ≥99th percentile)	23 (7)	12 (9)	11 (7)
Partial or complete parent participation, no. (%)	169 (55)	80 (56)	89 (53)
Caregivers			
Total no.	133	65	68
Age, mean (SD)	41.7 (6.5)	42.4 (6.8)	41.1 (6.1)
Sex, no. (%)			
Female	127 (95)	63 (97)	4 (94)
Male	6 (5)	2 (3)	4 (6)
Race, no. (%)			
Black	3 (2)	1 (2)	2 (3)
White	126 (95)	62 (95)	64 (94)
Other or unknown	4 (3)	2 (3)	2 (3)
Hispanic ethnicity, no. (%)	0	0	0

Abbreviations: BMI, body mass index, GED, General Educational Development.
[a] The Kids SIP*smart*ER cluster randomized controlled trial occurred from the 2018–2019 through the 2021–2022 academic school years in 12 middle schools in southwestern Virginia and West Virginia (10).
[b] Data available for 291 students.
[c] Calculated as weight in kilograms divided by height in meters squared.

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Table. Baseline Demographic Characteristics of Enrolled Students and Caregivers Who Completed Baseline, 7-Month, and 19-Month Assessments, Overall and by Randomized Condition, Kids SIP*smart*ER

Characteristic	Overall	By randomized condition	
		Kids SIP*smart*ER[a]	Control
Education, no. (%)			
High school diploma, GED, or less	28 (21)	13 (20)	15 (22)
Some college, associate degree	53 (40)	29 (45)	24 (35)
4-Year college degree or higher	48 (36)	22 (34)	26 (38)
Other or unknown	4 (3)	1 (1)	3 (4)
Annual household income, no. (%)			
<$25,000	17 (13)	11 (17)	6 (9)
$25,000-$49,999	26 (20)	8 (12)	18 (26)
$50,000-$74,999	24 (18)	15 (23)	9 (13)
≥$75,000	46 (35)	22 (34)	24 (35)
Other or unknown	20 (15)	9 (14)	11 (16)
BMI, mean (SD)[c]	30.8 (7.9)	31.2 (7.7)	30.4 (8.2)
BMI categories, no. (%)			
Underweight (BMI <18.5)	2 (1)	0	2 (3)
Healthy weight (BMI 18.5–24.9)	26 (20)	12 (18)	14 (21)
Overweight (BMI 25.0–29.9)	41 (31)	19 (29)	22 (32)
Obesity (BMI 30.0–34.9)	24 (18)	14 (22)	10 (15)
Severe obesity (BMI ≥35.0)	31 (23)	17 (26)	14 (21)
Other or unknown	9 (7)	3 (5)	6 (9)
Weight, mean (SD)			
In kilograms	85.1 (25.1)	85.5 (24.6)	84.7 (25.8)
In pounds	187.6 (55.4)	188.5 (54.2)	186.7 (56.9)

Abbreviations: BMI, body mass index, GED, General Educational Development.
[a] The Kids SIP*smart*ER cluster randomized controlled trial occurred from the 2018–2019 through the 2021–2022 academic school years in 12 middle schools in southwestern Virginia and West Virginia (10).
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Supplemental Table. Study Enrollment and Retention by Randomized Condition, Kids SIP*smart*ER[a]

Stage of intervention	Intervention	Control
Determined to be eligible for enrollment		
No. of dyads	620	802
No. of dyads per school/cluster, median (range)	97 (63–172)	137 (77–164)
Reasons for not enrolling		
Students		
No parental consent	234	462
Parental consent, but no student assent	19	20
Parental consent and student assent, but no baseline data	10	21
All reasons, no./total (%)	263/620 (42)	494/802 (62)
Caregivers		
No consent	391	573
Consent, but no baseline data	39	71
Both reasons, no./total (%)	430/620 (69)	644/802 (80)
Enrollment		
Students		
No. of students	357	308
Median (range) per school/cluster	57 (23–117)	51 (38–68)
Caregivers		
No. of caregivers	190	158
Median (range) per school/cluster	30 (10–71)	23 (15–46)
7-Month follow-up (after excluding those with no 7-month data)		
Students		
No. of students	329	258
Median (range) per school/cluster	50 (21–113)	39 (33–60)
Caregivers		
No. of caregivers	126	110
Median (range) per school/cluster	18 (5–54)	17 (11–30)
Included in 7-month analysis (after excluding outliers)		
Students		
No. of students	306	220
Median (range) per school/cluster	46 (21–108)	35 (29–46)
Caregivers		
No. of caregivers	118	102
Median (range) per school/cluster	17 (5–49)	17 (10–25)

[a] The Kids SIP*smart*ER cluster randomized controlled trial occurred from the 2018–2019 through the 2021–2022 academic school years in 12 middle schools in southwestern Virginia and West Virginia (10).

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Supplemental Table. Study Enrollment and Retention by Randomized Condition, Kids SIP*smart*ER[a]

Stage of intervention	Intervention	Control
19-Month follow-up (after excluding those with no 19-month data)		
Students		
No. of students	154	170
Median (range) per school/cluster	27 (10–39)	27 (15–42)
Caregivers		
No. of caregivers	71	75
Median (range) per school/cluster	11 (4–27)	13 (7–18)
Included in 19-month analysis (after excluding outliers)		
Students		
No. of students	142	167
Median (range) per school/cluster	26 (10–36)	26 (15–42)
Caregivers		
No. of caregivers	65	68
Median (range) per school/cluster	9 (4–26)	11 (6–17)

[a] The Kids SIP*smart*ER cluster randomized controlled trial occurred from the 2018–2019 through the 2021–2022 academic school years in 12 middle schools in southwestern Virginia and West Virginia (10).

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RESEARCH BRIEF

Using Photovoice to Create Awareness and Proactive Attitudes Among Mothers of Preschool-Aged Children About the Prevalence of Ultraprocessed Food in the Local Food Environment

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PEER REVIEWED

Summary

What is known about this topic?

Ultraprocessed foods are deeply ingrained in US culture and encourage narrow diets with limited healthy options. Challenging the social acceptance of feeding children these foods is a priority.

What is added by this report?

We used photovoice to assess the perceptions of mothers of preschool-aged children of their local food environment. After taking photographs and participating in focus groups and a nutrition education session, mothers questioned the prevalence and marketing of ultraprocessed foods and discussed the need for change.

What are the implications for public health practice?

This project highlights the potential of participatory methods to generate grassroots momentum for advancing healthier food initiatives.

Abstract

Ultraprocessed foods are deeply ingrained in US culture, and challenging the social acceptance of feeding children ultraprocessed foods is a priority. We used photovoice among a sample of mothers of preschool-aged children (n = 25) to assess their perceptions of the local food environment. Participants had 2 weeks before and after a nutrition education session to take photographs. Participants submitted 814 photographs of the local food environment, and mothers participated in 8 focus group discussions, each with 5 to 8 participants. After the education session, participants questioned the prevalence and marketing of ultraprocessed foods and discussed the need for change, thus signaling proactive attitudes.

Objective

Ultraprocessed foods are deeply ingrained in US culture and account for 58% to 65% of children's energy intake (1–3). For example, common items on children's menus, in media advertisements, and on grocery store promotions include chicken nuggets or tenders, hamburgers, grilled cheese, french fries, hot dogs, and macaroni and cheese (4). Foods like these are aggressively marketed and highly palatable, and they encourage narrow diets with limited healthy options. These factors, in turn, can create children's resistance to new food, which can persist into adulthood, increasing lifetime risks of obesity and chronic disease (5).

Challenging the social acceptance of feeding children ultraprocessed foods is a priority, and raising awareness and reflection about their prevalence in the food environment is a crucial first step toward cultivating critical awareness (6). Photography involves active observation of the environment, making learning more personally relevant. Therefore, our partnership team, an academic institution, and a community agency collaborated to plan and implement a photovoice project. Photovoice is a research method in which community members identify and record issues in their communities by taking photographs, participating in dialogue about the problems, and disseminating the work to policymakers and other community members (7). This pilot study aimed to examine how participation in a photovoice project, combined with education on ultraprocessed foods, influenced mothers' perceptions and evaluations of their local food environment.

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Methods

In alignment with Freire's process of developing critical awareness (6), we used a community-based participatory research (CBPR) approach, using photovoice as the primary data collection method (6,8). After an introduction, participants conducted a food environment assessment using cameras, attended a nutrition education session, and then repeated the assessment. The educational session, held between the 2 assessments, focused on identifying ultraprocessed foods by examining ingredient lists and highlighting the benefits of unprocessed or minimally processed foods. The Rutgers University institutional review board approved the project.

The purposeful sample comprised female, English-speaking legal guardians (hereinafter "mothers") of preschool-aged children who were African American or Black, biracial or multiracial, or Hispanic or non-Hispanic, representing the predominant racial and ethnic demographic characteristics of families served by the community agency. Mothers were included as participants because prior surveys showed that they are the main food procurers for families served by the community agency. The urban Head Start community agency recruited mothers through project flyers, parent discussions at drop-off, and parent meetings. Data collection consisted of photographs taken by participants, focus group discussions about the photographs, and an electronic demographic questionnaire. To facilitate the food environment assessment, we provided participants with a Kodak PIXPRO FZ45 digital camera (Eastman Kodak Company) and a secure digital card. Participants were instructed on how to use the camera and to conduct the assessment by photographing food present in their neighborhoods — such as that found in grocery stores, in restaurants, and at social activities — that influenced how they feed their children.

Participants had 2 weeks before and after the education session to take photographs. After the 2 weeks posteducation, 2 researchers trained in qualitative methods facilitated focus group sessions on a secure Zoom platform (Zoom Communications, Inc) and offered lunchtime, evening, and weekend options for convenience. The community agency partner recommended Zoom meetings over in-person meetings to meet the needs of busy parents. During the focus groups, mothers' photographs were individually displayed for discussion (ie, photo elicitation) (9). These sessions lasted 60 to 75 minutes and were recorded and transcribed verbatim. The data were collected from February through May 2024. Participants received gift cards for their time.

We used SPSS version 29 (IBM) to analyze the questionnaire data and used NVivo version 14 (Lumivero) to analyze content from the focus group transcripts (10). Content analysis involved 2 analysts independently coding the focus group transcripts and photographs discussed. To ensure rigor, we conducted the data analysis after each focus group discussion to determine when we were no longer learning new information as an indicator for data saturation and implemented member checking during the photo-elicitation discussions to enhance credibility and objectivity (ie, participants clarified and verified interpretations). We held research team discussions to resolve discrepancies in coding between the analysts and to reach consensus on the analysis for dependability (11).

Results

Thirty-three participants consented to the study; 25 mothers completed all components of the photovoice project and were included in the data analysis. Eight mothers missed sessions due to time or work constraints. Most participants were Black or African American (n = 23, 92%), and 2 mothers identified as 2 or more races (8%) (Table).

Participants submitted 814 photographs of their local food environment. Eight focus group discussions, each with 5 to 8 participants, were conducted, comprising 4 pre-education and 4 posteducation sessions. The key finding of the photovoice project was a shift from individual-level, family concerns to system-level critical awareness and proactive attitudes toward local food environment issues. The pre-education photograph discussions tended to focus on immediate family concerns, such as costs, time, and difficulties with shopping and feeding young children. In comparison, the posteducation photograph discussions focused more on critical awareness of external environmental influences in the food environment, such as advertising and the prevalence of ultraprocessed foods. For example, during a pre-education discussion, a mother presented photographs of ultraprocessed foods her children had chosen at the grocery store. During the post–photo-elicitation discussion, she said she began thinking about the items her children chose, so she used a wheelchair to see which foods were visible to her children at their height at the grocery store. She remarked that she was shocked by the marketing aimed at children. The Figure provides other examples of these shifts in conversations during the photo-elicitation discussions.

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Figure. Examples of changes in photo-elicitation focus group discussions, pre-education and posteducation, among mothers of preschool-aged children, February–May 2024. The key finding of pre-education focused on immediate challenges related to family choices. The key finding of posteducation focused on an awareness of ultraprocessed food as well as more proactive attitudes about the system-level impacts on food for children.

Discussion

The photovoice project facilitated perceptual shifts among mothers of preschool-aged children, from focusing on household-level struggles to recognizing the systemic influences shaping family food choices. The outcomes were similar to outcomes of other photovoice projects; the participating mothers began to question the status quo, reflecting the development of critical awareness and proactive attitudes (12–14). Although our project focused uniquely on developing critical awareness about the prevalence of ultraprocessed food in the food environment, a scoping review of 25 studies that used photovoice to understand overall access to healthy food demonstrated its effectiveness in nutrition research (15).

Critical awareness and proactive attitudes are essential for problem-oriented cognition, which influences behaviors and intentions to drive change (6,16). In accordance with CBPR practice, the participating mothers' suggestions for change were disseminated in a photovoice exhibit at the community agency partner in December 2024 (8). Approximately 70 people attended, including academics, local leaders, community members, and representatives from various agencies. More information about the photovoice exhibit is available at https://sites.google.com/scarletmail.rutgers.edu/bps/kids-food-solutions.

Photovoice projects appear to be transformative, and the shift in perceptions of participating mothers was likely the result of active and collaborative learning opportunities provided through the approach, as well as the education (12–14). The educational session provided background information on ultraprocessed foods, and taking photographs engaged the mothers in observing their food environment as it relates to feeding young children. The focus group photo-elicitation discussions prompted reflection, leading to deeper understanding and connections, and enabled the documentation of the learning process. Participating in education and group discussions also may have influenced perceptions and subjective norms by providing social reinforcement and peer support, as described by Freire (6) and predicted by the Theory of Planned Behavior (17).

This was a small, observational, pilot study with inherent limitations, including limited data on actual behavior change or health outcomes. However, we used several strategies to ensure the rigor of the data analysis, and the quantity of photographs and the depth of discussions about them are indicators of the transferability of our findings to similar contexts.

Given that ultraprocessed foods are deeply ingrained in everyday life, it is notable that participants' perceptions of them shifted (3). Participants questioned the prevalence and marketing of ultraprocessed foods and discussed the need for change, thus signaling proactive attitudes. Although further research is needed to evaluate this approach fully, this project highlights the promising potential of participatory methods to generate grassroots momentum for advancing healthier food initiatives.

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Table

Table. Demographic Characteristics of Participating Mothers (n = 25), Photovoice Project on Ultraprocessed Food in the Local Food Environment, February–May 2024

Demographic characteristic	Number (%)
Race	
Black or African American	23 (92)
Two or more races	2 (8)
Non-Hispanic ethnicity	25 (100)
Education	
No high school diploma	2 (8)
GED or high school diploma	11 (44)
Some college	10 (40)
Completed bachelor's degree or higher	2 (8)
Relationship status	
Married	4 (16)
Separated	3 (12)
Single	18 (72)

Abbreviation: GED, general educational development.

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ORIGINAL RESEARCH

Parental Perceived Stress and Its Association With Childhood Obesity in Spain: The PASOS Study

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PEER REVIEWED

Summary

What is already known on this topic?

Parental perceived stress (PPS) is a potential factor in the development of childhood obesity. Parents under stress may have less time, energy, or emotional resources to support the healthy eating and lifestyle routines of their children, thus promoting the development of childhood obesity.

What is added by this report?

In a Spanish national representative sample of children and adolescents, with parental data also collected, higher PPS was associated with higher likelihood of obesity, even after adjusting for significant children's lifestyle variables.

What are the implications for public health practice?

This study highlights the importance of considering family stress and parental well-being in strategies to prevent childhood obesity and promote healthier lifestyle behaviors.

Abstract

Introduction

Parental perceived stress (PPS) is proposed to be a factor influencing children's weight status through behavioral and environmental mechanisms. We assessed the association between PPS and weight status among Spanish children and adolescents.

Methods

We used data from the first wave of the PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) study (2019–2020). The study included 1,023 children and adolescents whose parents completed the Perceived Stress Scale. Anthropometric measurements and data on physical activity, sleep, screen time, and dietary quality were collected. We classified parents into "low" stress (<50th percentile on Perceived Stress Scale) and "high" stress (≥50th percentile on Perceived Stress Scale). We assessed the association between PPS and obesity, adjusted for parents' perception of their own health and children's general fitness. We conducted linear regression analysis between PPS and children's body mass index (BMI) *z* score and waist-to-height ratio.

Results

Children of parents with high PPS had higher mean BMI (19.9 [SD, 3.8] vs 19.5 [3.3]; $P = .009$) and poorer general fitness ($P = .003$) than children of parents with low PPS. The prevalence of obesity was higher among children of high-stress (vs low-stress) parents (4.0% vs 1.6%); this association remained significant after adjustment (adjusted OR = 2.76; 95% CI, 1.08–7.06; $P = .03$). The linear analysis showed positive associations between PPS and both children's BMI *z* score and waist-to-height ratio.

Conclusion

Higher PPS was associated with an increased likelihood of obesity in Spanish children and adolescents. These findings underscore the

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importance of addressing family stress in strategies for preventing childhood obesity.

Introduction

Childhood overweight and obesity are major public health challenges in Spain and worldwide, given their high prevalence and long-term health implications (1). It is crucial to identify not only traditional determinants, such as poor diet, physical inactivity, or excessive sedentary behavior, but also psychosocial factors that may influence obesogenic patterns within the family environment (2).

Parental perceived stress (PPS) is a potential factor in the development of childhood obesity (3). PPS is defined as the extent to which parents perceive their lives as unpredictable, uncontrollable, and overloaded, according to the conceptual framework of the Perceived Stress Scale (4). Parenting behaviors can be considered potential consequences of elevated stress rather than components of the definition itself. Parents experiencing high stress levels may have less time, energy, or emotional resources to support healthy routines, which could lead to less structured mealtimes, greater reliance on convenience foods, and reduced supervision of children's screen time or physical activity (3). A systematic review concluded that different types of stress (general stress, parenting stress, or life events) may influence child weight outcomes through diverse behavioral and biologic pathways yet emphasized the need for further population-based studies controlling for mediators and confounders (5). From a physiologic perspective, chronic stress can disrupt hormonal balance, leading to higher cortisol levels and changes in appetite, sleep, and physical activity (6). Within the family setting, these stress-related mechanisms may promote an obesogenic environment, fostering unhealthy behaviors and weight gain in children. Indeed, evidence suggests that parental stress can indirectly contribute to child obesity through reduced meal planning, high consumption of energy-dense foods, and more permissive parenting styles (7,8).

To date, few studies in Spain have assessed the association between PPS and childhood obesity while also considering lifestyle behaviors such as physical fitness, sleep, screen time, and dietary quality as potential mediators or modifiers of this relationship. Although broader reviews highlight associations between parenting stress or parental behaviors and children's lifestyle factors and body mass index (BMI), the role of PPS evaluated in conjunction with lifestyle mediators remains underexplored, particularly in Spanish population-based samples (3,9). This study aimed to assess the association between PPS and weight status among Spanish children and adolescents participating in the first wave of PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) study while accounting for key lifestyle-related factors.

Methods

Study design

The PASOS study was an observational, cross-sectional, multicenter, nationally representative study designed to assess physical activity, sedentary behaviors, and obesity-related indicators among Spanish children and adolescents (10).

Participants, recruitment, data collection, and ethics

We used data from the first wave of the PASOS study (2019–2020), which included a representative sample of Spanish children and adolescents (hereinafter referred to only as children) and their parents or legal guardians (hereinafter referred to only as parents). Schools were invited to participate, and those agreeing to follow the study protocol were included. Participants were recruited through 247 educational centers proportionally distributed among 17 autonomous communities across Spain to ensure national representativeness. The study was conducted from March 2019 through February 2020 and included boys and girls aged 8 to 16 years. Additional inclusion criteria were considered, such as attendance at the participating school, signed consent, and assent from participants aged 12 years or older. Written informed consent was obtained from both parents and participating children. The study enrolled 3,802 children. Data collection was conducted by trained researchers belonging to 13 collaborating research groups and more than 70 field staff members. Children with intellectual disabilities that impeded questionnaire completion were excluded from participation; such exclusions were confirmed jointly by teachers and parents before final enrollment. Of the 3,802 enrolled children, we excluded 2,779 for not having available data on parental stress levels; the final sample consisted of 1,023 participants.

The study complied with the ethical standards of the Declaration of Helsinki, was approved by the Ethics Committee of the Fundació Sant Joan de Déu, and was registered in the International Standard Randomized Controlled Trial Number registry (ID 34251612) (11). Details on the study protocol are available elsewhere (10).

To mitigate the potential for variance between observers, field researchers participated in a 1-day training session conducted by the Gasol Foundation. The study collected data from 2 sources: validated questionnaires and anthropometric measurements.

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Validated questionnaires were administered to children to collect data on lifestyle variables and to parents to collect data on lifestyle variables, socioeconomic factors, and environmental variables. For this analysis, we extracted data on the following: parent's age, child's sex (male, female), parent's perception of own health (excellent, very good, good, poor or bad), and parent's employment status (working, home working, unemployed, student, or other [retirement or permanent disability]).

Anthropometric measurements included weight, height, and waist circumference of the participating children.

Parental perceived stress

PPS was assessed by using the Perceived Stress Scale (4), which was completed online by parents whose children participated in the study. The Perceived Stress Scale measures the degree to which personal life situations are considered stressful; it consists of 14 questions asking how often a person felt or thought in a certain way during the previous month. Each question has 5 possible answers from 0 (never) to 4 (very often). Seven positive items (questions 4, 5, 6, 7, 9, 10 13) are reversed scored (ie, assigned values such that 0 = 4, 1 = 3, 2 = 2, 3 = 1, 4 = 0). The scores of all 14 items are then summed. Scores can range from 0 to 56, with higher scores indicating a higher degree of stress.

PPS was reported by the caregiver identified as "Adult 1," defined as the parent who spent the most time caring for the child. Only this caregiver completed the questionnaire, and only their data were used for the analysis; therefore, no multiple responses were obtained for the same participant.

Physical fitness, sleep duration, sedentary behavior, and diet of the children

Perceived physical fitness was assessed by using the validated International Fitness Scale questionnaire, which shows good reliability (coefficients ranging from 0.68 to 0.80) (12). Sleep duration on weekdays and weekends was calculated as the difference between bedtime and wake-up time by using the validated Sleep Habits Survey (13); participants were classified according to compliance with the National Sleep Foundation sleep recommendations (14). Screen time was assessed by using the validated the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) screen time–based sedentary behavior questionnaire ($\kappa > 0.7$) (15), which considered total daily screen time on weekdays and weekends and adherence to the American Academy of Pediatrics' recommendation of less than 120 minutes per day (16). Dietary quality was evaluated by using the 16-item KIDMED index, a validated instrument for assessing adherence to the Mediterranean diet among Spanish children and adolescents (17–19), with total scores ranging from −4 to 12 and categorized as low, medium, or high adherence. All questionnaires were self-completed by children.

Anthropometric measurements

Measurements of body weight (kg), height (cm), and waist circumference (cm) of the participating children were performed following the standard protocol established by the World Health Organization (20). For body weight measurement, a SECA 899 electronic scale (SECA GmbH) was used; for height, a SECA 217 portable stadiometer (SECA GmbH) was used; and for waist circumference, a SECA 201 flexible tape measure (SECA GmbH) was used. Two waist circumference measurements were taken, and if the difference between the 2 measurements exceeded 1 cm, a third measurement was taken. From these measurements, BMI was calculated as weight in kilograms divided by height in meters squared. Weight status was based on the Orbegozo growth reference categories, which uses age- and sex-specific BMI cutoff points derived from Spanish percentile tables (21). The standardized BMI z score was compared with the WHO 2007 growth standards for children and adolescents (22), according to the BMI *z* score age and sex cutoffs (overweight and obese >1 SD; normal weight ≥−2 SD and ≤1 SD; and underweight <−2 SD). A waist-to-height ratio was computed by dividing waist circumference by height to provide a continuous marker of adiposity (23).

Statistical analysis

For statistical analysis, we used SPSS version 27.0 (IBM SPSS Statistics for Windows). We used Perceived Stress Scale scores to obtain the grouping variable. Scores were divided into 2 groups: we assigned "low perceived stress" to parents whose Perceived Stress Scale score was at or below the 50th percentile and "high perceived stress" to parents who were above the 50th percentile. We tabulated descriptive statistics for quantitative variables as mean (SD). We used the Student *t* test to assess differences between groups. For categorical variables, we tabulated frequency and percentage. We used χ^2 analysis to examine between-group differences in categorical variables. Statistical significance was determined at $P < .05$.

We used binary logistic regression to assess the association between the grouping variable (low or high perceived stress) and weight status–related variables. We calculated odds ratios (ORs) and their 95% CIs, with low perceived stress used as the reference category. Continuous anthropometric variables (weight, height, BMI, and waist circumference) were categorized by using the sample median as the cutoff, while weight status and abdominal obesity were analyzed as dichotomous variables (yes/no). The OR was calculated twice: first, unadjusted (crude OR), and second, ad-

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justed for parent's perception of own health, physical fitness of the child, as well as child's sex and age, as key covariates. Finally, we performed a linear regression analysis to examine the association between total Perceived Stress Scale and children's BMI *z* score and waist-to-height ratio.

Results

Sociodemographic characteristics of children and parents

We observed no differences in the mean age of children or parents between the low-stress and high-stress groups (Table 1). However, children with parents in the high-stress group had a slightly higher mean BMI than children with parents in the low-stress group (19.9 [SD, 3.8] vs 19.5 [SD, 3.3]; $P = .009$). The distribution of sex and the prevalence of abdominal obesity did not differ between groups. We found a higher proportion of children with obesity among parents in the high-stress group (4.0%) than among parents in the low-stress group (1.6%), but this difference was not significant ($P = .08$).

Parental health perception differed significantly between stress groups ($P < .001$). Parents with high perceived stress were less likely to report their health as excellent or very good (4.0% and 19.4%, respectively) and more likely to rate it as good or poor (64.5% and 11.2%, respectively) compared with parents with low perceived stress. Employment status did not differ significantly between groups.

Children's physical fitness, sleep duration, screen time, and diet quality

Children whose parents reported high stress had poorer general fitness than children whose parents reported low stress, with a higher proportion classified as having bad to acceptable fitness levels (30.6% vs 22.8%; $P = .003$) (Table 2). Similarly, cardiorespiratory fitness was significantly lower among children whose parents reported high stress ($P = .02$). We observed no differences between groups for muscle strength, speed and agility, or flexibility. The proportion of children who met the daily recommendation for moderate-to-vigorous physical activity was significantly lower among children whose parents reported high stress (77.8%) than among children whose parents reported low stress (82.7%) ($P = .005$). We found no differences between stress groups on weekdays or weekends.

Mean screen time tended to be higher among children whose parents reported high stress, both on weekdays (168.9 [SD, 144.3] vs 155.9 [136.8] min/d; $P = .06$) and weekends (263.7 [SD, 172.7] vs 265.7 [SD, 166.5] min/d, $P = .13$), but these differences were not significant. We found no differences in KIDMED scores between children whose parents reported low stress and children whose parents reported high stress (7.18 [SD, 2.4] vs 6.81 [SD, 2.5]; $P = .99$). A higher proportion of children whose parents reported high stress had low adherence to the Mediterranean diet compared with children whose parents reported low stress (8.9% vs 7.3%). Medium adherence was slightly more common among children whose parents reported high stress (52.5% vs 47.8%), while high adherence was more frequent among children whose parents reported low stress (45.0% vs 38.6%), but these differences were not significant ($P = .07$).

Anthropometric measurements

We observed no associations between parental stress groups and children's weight, height, BMI, or waist circumference, either in the crude or adjusted models (Table 3). We found no differences between parental stress groups for undernutrition, underweight, healthy weight, or overweight. Children whose parents reported high stress had a significantly higher likelihood of obesity compared with those whose parents reported low stress in both crude (OR = 2.51; 95% CI, 1.12–5.59; $P = .02$) and adjusted (OR = 2.76; 95% CI, 1.08–7.06; $P = .03$) models.

Linear regression analysis

Higher PPS was positively associated with both children's BMI *z* score and waist-to-height ratio (Table 4). PPS showed a small but significant effect on BMI z score ($P = .03$) and waist-to-height ratio ($P = .03$). Although the effect sizes were modest ($R^2 = 0.004$ for BMI *z* score and 0.005 for waist-to-height ratio), the direction of the associations indicated that higher PPS was related to slightly higher adiposity indicators in children.

Discussion

We found that children whose parents reported higher PPS levels had a higher likelihood of obesity, even after adjusting for potential confounders such as parental health perception and children's general physical fitness. We observed no associations for overweight status or other anthropometric measurements. These results suggest that PPS may play a relevant role in the development or maintenance of obesity in children, rather than influencing milder degrees of excess weight. Moreover, we conducted linear regression models using continuous anthropometric indicators (BMI z score and waist-to-height ratio) to increase statistical power. These analyses supported the main findings, showing that higher PPS was positively associated with slightly higher BMI z score and waist-to-height ratio values. Although the effect sizes were small, these continuous associations reinforce the robustness

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of the relationship between PPS and children's adiposity outcomes.

Previous studies showed that PPS is associated with less healthy dietary patterns in children and a high risk of overweight or obesity (5,24,25). High PPS was consistently linked to high BMI and obesity-related behaviors among children, particularly increased fast-food consumption (24–26). These findings are in line with our study results, where high PPS was also associated with high BMI among children.

In our study, higher PPS was also associated with worse general fitness status. Some evidence suggests that PPS may reduce children's physical activity, although this relationship is not yet clearly established (25,27,28). For example, many parents report that the high cost of organized sports and activity is a reason for stress, which may limit their ability to enroll their children in physical activity programs and thus indirectly reduce children's activity levels (29). Conversely, one study (25) found that higher PPS was associated not only with higher child BMI and fast-food consumption but also with increased physical activity, suggesting that stress may not always suppress movement in children. In a recent study, higher daily PPS was directly associated with lower child activity on the same day, although lagged effects showed a potential compensatory increase in activity the next day, especially among girls (28).

One factor that may also mediate the association between PPS and childhood obesity is the way that parents adapt their feeding practices during stressful periods. A clear example is the COVID-19 pandemic, during which both general and parenting stress increased substantially. Higher levels of stress were linked to the use of food to regulate children's emotions and behaviors, and to parents' perceptions of problematic eating patterns in their children (30). During the pandemic, PPS was also related to higher consumption of sweet and savory snacks mediated by snack parenting practices (31). Aside from the COVID-19 context, unhealthy eating habits have also been related to PPS and children's behavioral problems (32). Similarly to our study, no relation between PPS and dietary quality has been found in other PPS related studies (33). We observed no differences in adherence to a healthy diet, such as the Mediterranean diet, between children with parents reporting low stress and children with parents reporting high stress. Overall, although the evidence to date remains somewhat inconsistent, parental psychologic stress appears to influence the home food environment and may represent an important intervention tactic for improving children's dietary patterns. However, this association is likely to be complex and may be mediated by additional factors beyond diet, which could also contribute to the increased risk of obesity observed in children exposed to higher levels of parental stress.

Our findings suggest that lifestyle behaviors such as physical activity, dietary habits, and family routines may act as intermediate pathways linking parental stress and childhood obesity. However, given the cross-sectional design of our study, the temporal sequence between these factors cannot be established, and therefore mediation pathways should be interpreted with caution and further explored in longitudinal research. Additionally, we used descriptive analyses of lifestyle behaviors to inform the selection of covariates in the adjusted models. Variables showing relevant differences according to parental stress, such as physical activity, were considered in the OR analyses to reduce potential confounding.

Our study examined data on children's sleep duration and screen time, and we found no differences between PPS groups. Previous research reported inconsistent findings (27,34–36). Some research showed that when parents feel more stressed, their children may end up using screens for longer (37), possibly because stressed caregivers have a decreased ability to supervise or set limits (36). Other studies reported that high stress can have the opposite effect, prompting some parents to apply household rules more firmly, which can reduce the amount of time children spend on screens (35). These contrasting results may help to explain why we observed no differences in our sample.

Previous evidence on sleep time showed a direct relationship between screen exposure and sleep duration, with higher screen use generally associated with shorter sleep in children and adolescents (34). Other studies suggested that PPS may arise as a consequence of children's sleep difficulties rather than the reverse (38). Furthermore, research has consistently reported strong associations between PPS and children's sleep problems as well as links between parental mental health and children's sleep disturbances (39). Together, these findings highlight the complex and bidirectional relationships between children's sleep patterns, screen habits, and family stress.

Although the literature shows inconsistent associations between parental stress and children's physical activity, screen time, sleep duration, or overall diet quality, evidence consistently links higher parental stress with higher child BMI and increased fast-food consumption. These findings align with our study results and highlight fast-food intake as a relevant obesity-related behavioral factor that warrants further examination.

Finally, our findings also suggest that parents' perception of their own health may be linked to parental stress, offering an additional pathway through which stress could influence childhood obesity. Parents who view their own health as poorer often report higher stress levels, which may limit their ability to maintain consistent, health-promoting routines at home and may influence children's

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obesity risk indirectly (3,40,41). Overall, these results highlight that parents' health and psychosocial well-being form part of a broader context that may shape children's lifestyle patterns and weight outcomes. Taken together, these findings emphasize the need to consider parental psychosocial factors when addressing childhood obesity because they may shape children's health trajectories.

Strengths and limitations

The main strength of this study was the use of a representative sample of Spanish children, together with their parents. Although we used data from an analytic subsample (n = 1,023) of the larger PASOS study (n = 3,802), our study provides valuable insights into the association between PPS and childhood obesity. The standardized procedures used for anthropometric measurements and physical fitness assessments also enhance the reliability of the data. The inclusion of multiple lifestyle-related variables, such as physical activity, sleep duration, screen time, and dietary quality, provides a broader understanding of the context in which parental stress may influence child health. Adjusted OR models, stratified by parents' perception of their own health, general fitness status of the child, and child's sex and age, allow consideration of possible confounders in the relationship between parental stress and child obesity risk. The inclusion of linear regression analyses using continuous adiposity indicators (BMI *z* score and waist-to-height ratio) is an additional strength, as these models provide greater statistical power compared with categorical approaches. However, our study has several limitations. First, the cross-sectional design precludes establishing causal relationships between PPS and children's weight status. Second, key variables such as PPS, perceived health, dietary patterns, sleep duration, and screen time were assessed through self-reported questionnaires, which may be subject to recall or social desirability bias. In addition, the potential for selection bias related to participation and missing data, as well as residual confounding despite statistical adjustment, may still exist. The PASOS study was designed to be nationally representative; our analytic subsample may slightly limit the generalizability of the findings to the broader population of children in Spain and must be considered when interpreting the results. Finally, it cannot extrapolate to other populations.

Conclusion

In this nationally representative sample of Spanish children, with parental data also collected, higher PPS was associated with a higher likelihood of obesity, even after adjusting for significant children lifestyle variables, such as physical activity, and parents' perception of their own health. We found no differences between children in overweight status or other anthropometric indicators according to PPS, suggesting that PPS may be more strongly linked to more severe excess weight. However, linear regression analyses using continuous adiposity markers revealed small but positive associations with PPS, which highlights the importance of considering family stress and parental well-being in strategies aimed at preventing childhood obesity and promoting healthier lifestyle behaviors.

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Tables

Table 1. Sociodemographic Characteristics of Children, Adolescents, and Parents According to Parental Perceived Stress,[a] Spain, 2019–2020[b]

Characteristic	Parent's Perceived Stress Scale[c]		*P* value[d]
	Low (n = 549)	High (n = 474)	
Child, mean (SD)			
Age, y	12.4 (2.3)	12.3 (2.4)	.10
BMI, kg/m^2	19.5 (3.3)	19.9 (3.8)	.009
Parent, mean (SD)			
Age, y	45.1 (5.5)	44.8 (5.8)	.63
BMI, kg/m^2	24.9 (4.1)	25.3 (4.5)	.12
Child's sex, no (%)			
Female	277 (50.5)	231 (48.7)	.58
Male	272 (49.5)	243 (51.3)	
Child's weight status (both sexes), no. (%)			
Undernutrition	8 (1.5)	5 (1.1)	.08
Underweight	33 (6.0)	35 (7.4)	
Healthy weight	414 (75.4)	330 (69.6)	
Overweight	85 (15.5)	85 (17.9)	
Obesity	9 (1.6)	19 (4.0)	
Abdominal obesity (waist-to-height ratio >0.5)	93 (16.9)	92 (19.4)	.32
Parent's perception of own health, no. (%)			
Excellent	42 (7.7)	19 (4.0)	<.001
Very good	216 (39.3)	92 (19.4)	
Good	272 (49.6)	306 (64.5)	
Poor	16 (2.9)	53 (11.2)	
Bad	3 (0.5)	4 (0.8)	
Parent's employment status, no (%)			
Working	420 (76.5)	342 (72.2)	.10
Home working	66 (12.0)	66 (13.9)	
Unemployed	31 (5.6)	40 (8.4)	
Student	1 (0.2)	4 (0.8)	
Other (retirement or permanent disability)	31 (5.6)	22 (4.6)	

Abbreviation: BMI, body mass index.
[a] Defined as the extent to which parents perceive their lives as unpredictable, uncontrollable, and overloaded, according to the conceptual framework of the Perceived Stress Scale (4).
[b] Data source: First wave of the PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) Study (10).
[c] Perceived Stress Scale scores were divided into 2 groups: "low perceived stress" to parents whose score was at or below the 50th percentile and "high perceived stress" to parents who were above the 50th percentile.
[d] Differences in groups were examined by using χ^2 and Student *t* test.

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Table 2. Children's and Adolescents' Physical Fitness, Sleep Duration, Screen Time, and Diet Quality According to Parental Perceived Stress,[a] Spain, 2019–2020[b]

Characteristic	Parent's Perceived Stress Scale[c]		*P* value[d]
	Low (n = 549)	High (n = 474)	
Physical fitness, no. (%)			
General fitness status			
Bad to acceptable	125 (22.8)	145 (30.6)	.003
Good to very good	424 (77.2)	329 (69.4)	
Cardiorespiratory fitness			
Bad to acceptable	152 (27.7)	145 (30.6)	.02
Good to very good	397 (72.3)	329 (69.4)	
Muscle strength			
Bad to acceptable	190 (34.6)	161 (34.0)	.20
Good to very good	359 (65.4)	313 (66.0)	
Speed and agility			
Bad to acceptable	175 (31.9)	182 (38.4)	.26
Good to very good	374 (68.1)	292 (61.6)	
Flexibility			
Bad to acceptable	315 (57.4)	168 (35.4)	.89
Good to very good	234 (42.6)	306 (64.6)	
Moderate-to-vigorous physical activity recommendation achieved	454 (82.7)	369 (77.8)	.005
Sleep duration			
Total sleep time, mean (SD), hours per weekday	9.0 (1.3)	8.9 (1.3)	.16
Total sleep time, mean (SD), hours per weekend	9.8 (1.6)	9.9 (1.6)	.62
Sleep time recommended achieved on weekdays, no. (%)	341 (62.1)	296 (62.4)	.96
Sleep time recommended achieved on weekends, no. (%)	276 (50.3)	242 (51.1)	.84
Screen time			
Total screen time, mean (SD), minutes per weekday	155.9 (136.8)	168.9 (144.3)	.06
Total screen time, mean (SD), minutes per weekend	265.7 (166.5)	263.7 (172.7)	.13
Screen time recommendation achieved on weekdays, no. (%)	272 (49.5)	216 (45.6)	.13
Screen time recommendation achieved on weekends, no (%)	114 (20.8)	121 (25.5)	.09
Diet quality[e]			
KIDMED score, mean (SD)	7.18 (2.4)	6.81 (2.5)	.99

[a] Defined as the extent to which parents perceive their lives as unpredictable, uncontrollable, and overloaded, according to the conceptual framework of the Perceived Stress Scale (4).
[b] Data source: First wave of the PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) Study (10).
[c] Perceived Stress Scale scores were divided into 2 groups: "low perceived stress" to parents whose score was at or below the 50th percentile and "high perceived stress" to parents who were above the 50th percentile.
[d] Differences in groups were examined by using χ^2 and Student *t* test.
[e] Evaluated by using the 16-item KIDMED index, a validated instrument for assessing adherence to the Mediterranean diet among Spanish children and adolescents (17–19), with total scores ranging from –4 to 12 and categorized as low, medium, or high adherence.

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(continued)

Table 2. Children's and Adolescents' Physical Fitness, Sleep Duration, Screen Time, and Diet Quality According to Parental Perceived Stress,[a] Spain, 2019–2020[b]

Characteristic	Parent's Perceived Stress Scale[c]		*P* value[d]
	Low (n = 549)	High (n = 474)	
KIDMED adherence			
Low	40 (7.3)	42 (8.9)	.07
Medium	262 (47.8)	249 (52.5)	
High	247 (45.0)	183 (38.6)	

[a] Defined as the extent to which parents perceive their lives as unpredictable, uncontrollable, and overloaded, according to the conceptual framework of the Perceived Stress Scale (4).
[b] Data source: First wave of the PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) Study (10).
[c] Perceived Stress Scale scores were divided into 2 groups: "low perceived stress" to parents whose score was at or below the 50th percentile and "high perceived stress" to parents who were above the 50th percentile.
[d] Differences in groups were examined by using χ^2 and Student *t* test.
[e] Evaluated by using the 16-item KIDMED index, a validated instrument for assessing adherence to the Mediterranean diet among Spanish children and adolescents (17–19), with total scores ranging from –4 to 12 and categorized as low, medium, or high adherence.

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Table 3. Association of Children's and Adolescents' Anthropometric Measurements According to Parental Perceived Stress,[a] Spain, 2019–2020[b]

Measurement	Perceived Stress Scale[c]		*P* value[d]
	Low (n = 528)	High (n = 544)	
Weight in kg[e]			
Crude OR	1 [Reference]	1.05 (0.82–1.35)	.70
Adjusted OR[f]	1 [Reference]	0.95 (0.72–1.27)	.74
Height in m[e]			
Crude OR	1 [Reference]	1.05 (0.82–1.34)	.73
Adjusted OR[f]	1 [Reference]	1.05 (0.79–1.38)	.76
BMI[e]			
Crude OR	1 [Reference]	1.20 (0.93–1.54)	.16
Adjusted OR[f]	1 [Reference]	1.05 (0.79–1.40)	.75
Waist circumference in cm[e]			
Crude OR	1 [Reference]	1.20 (0.94–1.54)	.15
Adjusted OR[f]	1 [Reference]	1.05 (0.79–1.40)	.74
Weight status[g]			
Undernutrition			
Crude OR	1 [Reference]	0.72 (0.23–2.22)	.57
Adjusted OR[f]	1 [Reference]	0.82 (0.25–2.71)	.75
Underweight			
Crude OR	1 [Reference]	1.25 (0.76–2.04)	.38
Adjusted OR[f]	1 [Reference]	1.17 (0.68–2.01)	.56
Healthy weight			
Crude OR	1 [Reference]	0.76 (0.58–1.00)	.05
Adjusted OR[f]	1 [Reference]	0.83 (0.61–1.14)	.26
Overweight			
Crude OR	1 [Reference]	1.19 (0.86–1.66)	.29
Adjusted OR[f]	1 [Reference]	1.03 (0.71–1.51)	.86
Obesity			
Crude OR	1 [Reference]	2.51 (1.12–5.59)	.02
Adjusted OR[f]	1 [Reference]	2.76 (1.08–7.06)	.03
Abdominal obesity[g]			
Crude OR	1 [Reference]	1.18 (0.86–1.62)	.32
Adjusted OR[f]	1 [Reference]	0.98 (0.68–1.42)	.92

Abbreviations: BMI, body mass index; OR, odds ratio.
[a] Defined as the extent to which parents perceive their lives as unpredictable, uncontrollable, and overloaded, according to the conceptual framework of the Perceived Stress Scale (4).
[b] Data source: First wave of the PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) Study (10).
[c] Perceived Stress Scale scores were divided into 2 groups: "low perceived stress" to parents whose score was at or below the 50th percentile and "high perceived stress" to parents who were above the 50th percentile.
[d] $P < .05$ considered significant.
[e] Continuous anthropometric measurements were categorized by using the sample median as the cutoff.
[f] Adjusted by parent's perception of own health and general fitness status, age, and sex of the child.
[g] Weight status and abdominal obesity were analyzed as dichotomous variables (yes/no).

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Table 4. Linear Regression Analysis Between Parental Perceived Stress[a] and Children's BMI *z* Score and Waist-to-Height Ratio, Spain, 2019–2022[b]

Value	BMI *z* score	Waist-to-height ratio
R (correlation coefficient)	0.067	0.068
R^2 (determination coefficient)	0.004	0.005
y =	$0.23 + (0.01 \times x)$	$0.44 + [(4.85 \times 10^{-4}) \times x]$
95% CI	0.001 to 0.019	0.000048 to 0.001
P value	.03	.03

Abbreviation: BMI, body mass index.
[a] Defined as the extent to which parents perceive their lives as unpredictable, uncontrollable, and overloaded, according to the conceptual framework of the Perceived Stress Scale (4). Scores were divided into 2 groups: "low perceived stress" to parents whose score was at or below the 50th percentile and "high perceived stress" to parents who were above the 50th percentile.
[b] Data source: First wave of the PASOS (Physical Activity, Sedentarism, and Obesity in Spanish Youth) Study (10).

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