Recent Trends in Junk Food Intake in U.S. Children and Adolescents, 2003–2016

Elizabeth K. Dunford, PhD,^{1,2} Barry M. Popkin, PhD,^{2,3} Shu Wen Ng, PhD^{2,3}

Introduction: In the U.S., there is no consensus of how to define *junk food*. Strict regulations on what constitutes junk food denoted by front-of-package labels can serve as the basis for statutory actions. Chile was the first country to adopt this approach, and several countries have followed suit. This study examined the proportion of calories and nutrients of concern consumed by U.S. children and adolescents defined as junk food using the Chilean label criteria and the changes between 2003 and 2016.

Methods: Data were obtained from 4 nationally representative food intake surveys in 13,016 U.S. children and adolescents: National Health and Nutrition Examination Survey 2003–2004, 2005–2006, 2013–2014, and 2015–2016, with analysis performed in 2019. Nutritional content of each consumed food was compared with nutrient thresholds from the Chilean regulation for energy, saturated fat, total sugars, and sodium per 100 g.

Results: Between 2003 and 2016, there was a 10 percentage point decrease (71.1%–61.3%, $p<0.01$) in the proportion of foods consumed that were classified as junk food. A significant decrease was seen in mean intake of calories (1,610–1,367 kcal/day, $p<0.01$), total sugar (88.8–64.2 g/day, $p<0.01$), saturated fat (22.6–20.5 g/day, $p<0.01$), and sodium (2,306–2,044 mg/day, $p<0.01$).

Conclusions: Although junk food intake has decreased since 2003–2006, diets of U.S. children and adolescents remain dominated by less-healthy foods. These results can help guide policy regulations regarding foods and beverages accessible in schools and marketed to children, adolescents, and their caregivers.

Am J Prev Med 2020;59(1):49–58.

INTRODUCTION

Currently, around 1 in 5 children in the U.S. are obese.¹ Children with obesity are more likely than normal weight children to remain obese as adults^{2–6} and more likely to develop diseases such as diabetes, heart disease, and cancer at a younger age and face shorter life expectancies.^{6–14} Higher population levels of obesity are attributed to many factors, including consuming food outside the home, consuming larger portion sizes, and high intake of sugar-sweetened beverages.^{15–19} Recent research has suggested a plateauing of obesity levels in children and adolescents^{20,21} and a decline in energy intakes of U.S. households with children.²² Despite these declines, around two thirds of dietary energy still derives from highly processed food sources.^{23–26} More recently, an important crossover RCT by Hall et al.²⁷ reported that

a diet of ultraprocessed foods was linked with 2.4 lb weight gain over 2 weeks. By contrast, subjects had an average weight loss of 2 lbs in 2 weeks when switching from an ultraprocessed diet to a less processed one, clarifying the significance of the many studies linking ultraprocessed foods with lower dietary quality,²⁸ higher obesity

From the ¹Food Policy Division, The George Institute for Global Health, University of New South Wales, Sydney, Australia; ²Department of Nutrition, Gillings Global School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina; and ³Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

Address correspondence to: Elizabeth K. Dunford, PhD, Carolina Population Center CB# 8120 Carolina Square, University of North Carolina at Chapel Hill, Chapel Hill NC 27516.

E-mail: edunford@georgeinstitute.org.au.

0749-3797/\$36.00

<https://doi.org/10.1016/j.amepre.2020.01.023>

prevalence,^{27,29,30} and all-cause mortality.³¹ Previous studies have also revealed that disparities in dietary quality exist in certain demographic subgroups,^{32,33} and that black non-Hispanic children and adolescents and lower income households had the largest increase in snack food intake during the past 35 years.³⁴

In the U.S., the term *junk foods* is often used to describe commonly known less-healthy food categories such as confectionery, ice cream, and salty snacks. In the literature, the term is often used when observing the effects of bans on marketing to children or in relation to junk food taxes. Both marketing bans and junk food taxes usually involve a set of inclusion and exclusion criteria. For example, both Mexico and Hungary have implemented junk food taxes, with cutoffs for energy density (Mexico) and salt, sugar, and caffeine (for Hungary) used to determine what qualifies as junk food to be taxed.^{35–37} However, there is no consistent definition. Increasingly, studies have begun using degree of food processing to define less-healthy foods (e.g., *ultraprocessed* versus *minimally processed*).^{26,38} Nutrient profiling is also used in multiple countries to support consumers in identifying healthier products.³⁹

In 2016, Chile implemented the most comprehensive set of obesity-preventive regulations to date in the world, including strict regulations for the marketing of foods to children.^{40,41} This law was based on a nutrient profiling model that delineated foods high in total sugar, saturated fat, sodium, or calories using both nutrient levels and the presence of added sugar, salt, and saturated fat ingredients (as a proxy for degree of processing). Since Chile’s ground-breaking regulations, similar warning labels have been adopted in Israel,⁴² Peru, and Uruguay. Chile’s regulations came in 3 phases of increasing stringency. All subsequent countries that adopted this type of regulation began with criteria close to Chile’s second phase.

This study examined the proportion of calories and nutrients of concern consumed by children and adolescents in the U.S. that would be considered junk food using the Chilean regulation’s Phase 2 nutrient criteria and whether this changed between 2003 and 2016.

METHODS

Study Population

Data were obtained from 4 nationally representative surveys of food intake in 13,016 U.S. children and adolescents: National Health and Nutrition Examination Survey (NHANES) 2003–2004, NHANES 2005–2006 (NHANES 2003–2006), NHANES 2013–2014, and NHANES 2015–2016 (NHANES 2013–2016) (Table 1). NHANES is based on a multistage, stratified area probability sample of non-institutionalized U.S. households. Detailed information about each survey and its sampling design has been published previously.⁴³ Using secondary U.S. Department of

Table 1. Sociodemographic Characteristics for U.S. Children ≤18 Years

Characteristics	2003–2006	2013–2016
Number of observations	7,336	5,680
Male, %	49.4	50.4
Age group, %		
2–5 years	22.8	23.8
6–11 years	26.1	36.7
12–18 years	51.2	39.4
Race-ethnicity, %		
Mexican American	31.6	22.2
Other Hispanic	3.4	11.2
White non-Hispanic	27.3	27.9
Black non-Hispanic	32.6	23.8
Other race	5.2	14.9
Household income, %		
<185% federal poverty level	55.7	57.9
185%–350% federal poverty level	23.6	22.4
>350% federal poverty level	20.8	19.7
Head of household education, %		
Less than high school diploma	32.2	23.9
High school diploma	24.8	22.1
More than high school diploma	43.0	54.1

Agriculture (USDA) and NHANES data, this study was exempted from IRB concerns.

Measures

Although the Chilean regulation was first implemented in 2016, the nutrient thresholds were set to become increasingly stringent over a series of 3 implementation dates, beginning in 2016 and ending in 2019. The Phase 2 criteria were utilized for this analysis on the basis that these criteria are most widely used in the literature and were adopted by Israel after seeing the extensive reformulation industry undertook after the first phase of the Chilean regulations.^{37,42} Nutritional content of each food consumed in NHANES was compared with the Phase 2 thresholds from the Chilean regulation for energy, saturated fat, total sugars, and sodium per 100 g (Appendix Table 1, available online).⁴¹ Products that exceeded the nutrient thresholds were considered junk foods in this analysis and will be referred to as junk foods throughout this paper. The Chilean regulation also includes an ingredient criterion, with products containing added sugars (e.g., sucrose), saturated fat (e.g., palm oil), or sodium (e.g., table salt) ingredients and exceeding the nutrient criteria considered junk foods. Ingredient data for NHANES 2003–2006 were not available for this research, and so the authors did not include the ingredient criteria in the change analysis. However, Steele et al.,^{24,25} along with collaborators at the Centers for Disease Control and Prevention, provided data for this study identifying products from NHANES 2013–2016 that have added sugar, added saturated fat, or added salt ingredients. Using these data, overall results for 2013–2016 are shown using both the nutrient criteria alone and also including

the added ingredient criteria in the Chilean regulation ([Appendix Figure 1](#), available online). For sensitivity analyses, duplicate results tables for Chile's much more stringent Phase 3 criteria are available on request from the authors.

To examine trends over time from surveys with different collection methods on Days 1 and 2, the first day's data (a single, interviewer-administered 24-hour dietary recall) collected from each individual were used (as recommended by the USDA) and appropriate weights and adjustments were used for the sample design provided.

All foods reported in the USDA surveys were assigned to one of University of North Carolina-Chapel Hill's food groups.⁴⁴ To determine which food groups to focus on in reporting, data were pooled for all survey years (2003–2016). To focus on food categories of interest, the analysis was limited to categories with >50% of products classified as junk food under the Chilean Phase 2 nutrient criteria. All remaining food sources were grouped together ([Appendix Table 2](#), available online). Mean intake and proportion of calories, saturated fat, total sugar, and sodium provided by each food category were calculated.

Statistical Analysis

Analysis was undertaken in 2019. Junk food intake was examined using 3 age groups (2–5 years, 6–11 years, and 12–18 years), 5 race or ethnicity groups (Mexican American, other Hispanic, white non-Hispanic, black non-Hispanic, and other race), 2 sexes (male and female), 3 income groups (<185%, 185%–350%, and >350% of the Federal Poverty Level), and 3 head of household education groups (less than high school, high school diploma, and more than high school). Mean intake and proportion of calories and other nutrients of concern deriving from junk food overall and within each food category were determined, as were the mean number of junk food items consumed per day. The proportion of foods and beverages consumed by NHANES participants that were considered junk food was also calculated. Survey methods were used within Stata to account for the clustering that is inherent in the NHANES sampling methodology and weighting for national representativeness and to allow statistically significant differences between survey cycles to be identified using Student's *t*-test. Unadjusted models were used to ensure the representativeness of the U.S. population was maintained in each examined survey cycle. A *p*-value <0.01 was considered significant. Stata, version 14.1 was used for analysis.

RESULTS

Between 2003–2006 and 2013–2016, there was an almost 10 percentage point decrease (71.1%–61.3%, $p<0.01$) in the proportion of foods consumed by U.S. children and adolescents that were classified as junk food under the Chilean nutrient criteria ([Table 2](#)). A significant decrease was seen in mean intake of calories (1,610–1,367 kcal/day, $p<0.01$), total sugar (88.8–64.2 g/day, $p<0.01$), saturated fat (22.6–20.5 g/day, $p<0.01$), and sodium (2,306–2,044 mg/day, $p<0.01$) deriving from junk foods between survey years ([Table 3](#)). Between 2003–2006 and 2013–2016, the mean number of junk food items consumed each day decreased from

10.1 to 8.4 ($p<0.01$) ([Table 3](#)). Despite this, almost 75% of calories consumed and 90% of total sugars consumed in 2013–2016 derived from junk foods ([Table 3](#)).

All subgroups showed a significant decrease in mean calorie intake ([Figure 1A](#)) and total sugar ([Figure 1B](#)) deriving from junk foods between 2003–2006 and 2013–2016. Almost all subgroups also had a significant decrease in saturated fat ([Figure 1C](#)) and sodium ([Figure 1D](#)), with some exceptions. For example, Mexican Americans were the only racial or ethnic subgroup that did not show a significant decrease in saturated fat and sodium intake deriving from junk foods ([Figure 1C and D](#)). The lowest education group also showed no significant decreases in mean saturated fat or sodium intake deriving from junk foods. White non-Hispanics had the highest mean energy, total sugar, saturated fat, and sodium intake deriving from junk foods of all racial or ethnic groups ([Figure 1](#)). The highest income group had the highest absolute intake of energy, saturated fat, and sodium.

The addition of the ingredient criteria to the 2013–2016 data resulted in a decrease in the amount and proportion of calories, total sugar, saturated fat, and sodium deriving from junk foods ([Table 3](#)). The largest difference was in saturated fat, with a decrease from 20.5 g (61.3%) to 14.5 g (43.4%). The smallest difference was in total sugar, with a decrease from 64.2 g (90%) to 58.8 g (82.4%). Overall, the proportion of calories deriving from junk food was overestimated by 28% using the Chilean regulation's nutrient criteria without the addition of the ingredient criteria. Saturated fat was overestimated by 41%, sodium by 22%, and sugar by only 9%. Overestimates were due to differences in a few key food categories (outlined in the following section). When the ingredient criteria were included in analysis, black non-Hispanic children and adolescents consumed the highest proportion of calories, sugar, and saturated fat from junk food, yet white non-Hispanic children and adolescents consumed the highest proportion when the ingredient criteria were not included ([Figure 1](#)).

There was a large decrease in mean calorie intake from sugar-sweetened beverages between 2003 and 2016 (185–98 kcal/day, $p<0.01$) ([Appendix Table 3](#), available online). Despite less than half of products consumed from the bread category classified as junk foods in 2013–2016, >80% of calories, total sugar, saturated fat, and sodium in this category derived from junk foods. Mean calorie intake from juice products decreased between 2003 and 2016 (57–38 kcal/day, $p<0.01$).

One hundred percent of calories in dairy with added sugar, ready-to-eat cereals, and salty snacks were from junk foods in both time periods ([Table 2](#)), although there was a significant decrease in mean calories from junk

Table 2. Proportion of Food Reported Consumed by U.S. Children and Adolescents Classified as Junk Foods in NHANES 2003–2016, by Food Category

Food category	All children			Age 2–5 years			Age 6–11 years			Age 12–18 years		
	2003–2006	2013–2016 ^a	2013–2016 ^b	2003–2006	2013–2016 ^a	2013–2016 ^b	2003–2006	2013–2016 ^a	2013–2016 ^b	2003–2006	2013–2016 ^a	2013–2016 ^b
Ready-to-eat cereals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.9	100.0	99.9	99.9
Confectionery	99.9	98.2	98.2	99.8	98.7	98.7	99.9	97.9	97.9	99.9	98.2	98.2
Dairy with added sugar	99.9	99.9	87.7	100.0	100.0	76.3	99.8	99.8	92.6	99.9	100.0	89.7
Salty snacks	99.9	100.0	99.0	100.0	100.0	98.7	99.9	100.0	99.4	100.0	100.0	98.9
Processed meat, poultry, and fish	99.4	98.5	79.5	97.9	98.6	81.4	100.0	98.7	80.0	99.8	98.3	77.8
Breads	66.2	44.7	44.6	72.4	42.9	42.9	69.0	45.4	45.3	60.3	44.9	44.9
Juices	98.1	94.4	1.2	98.7	92.5	0.7	97.3	95.2	1.7	98.1	95.6	1.4
Cheese and cheese products	97.6	98.5	33.2	97.1	97.2	31.6	95.7	98.4	34.4	99.4	99.3	33.2
Desserts	92.3	93.1	89.9	89.7	90.2	88.9	92.0	91.8	88.0	94.5	97.0	92.9
Sugar-sweetened beverages	90.4	87.8	86.7	87.1	87.9	86.4	90.2	87.1	86.0	91.7	88.5	87.5
Sandwiches, burgers, and pizzas	79.9	76.8	69.5	80.0	80.4	72.9	81.7	78.9	72.1	78.4	73.4	65.7
All other foods	49.4	38.4	16.1	50.8	39.4	13.3	49.7	39.4	16.9	48.2	36.7	17.2
Total for all foods	71.1	61.3	43.5	71.3	61.4	39.8	71.8	63.1	45.9	70.2	59.6	43.5

^aJunk food is defined by using the Chilean nutrition profile model Phase 2 nutrient criteria.

^bJunk food is defined by using the Chilean nutrition profile model Phase 2 nutrient criteria in addition to the NOVA criteria for level of processing to identify products with added sugar, saturated fat, and sodium ingredients.

NHANES, National Health and Nutrition Examination Survey.

Table 3. Nutrient Intake Deriving From Junk Food Sources Overall and by Demographic Subgroup

Variable	Junk food items, n/d			Per capita intake from junk food		
	2003–2006	2013–2016	2013–2016 ^a	2003–2006 Mean intake (% total intake)	2013–2016 Mean intake (% total intake)	2013–2016 ^a Mean intake (% total intake)
Energy, kcal/day						
All children, 2–18 years	10.1	8.4	6.0	1,610 (77.0)	1,367 (72.2)	1,072 (56.6)
Age group						
2–5 years	11.2	9.3	6.0	1,256 (76.1)	1,070 (71.9)	784 (52.7)
6–11 years	10.7	9.2	6.7	1,615 (78.0)	1,428 (73.6)	1,151 (59.3)
12–18 years	9.0	7.4	5.4	1,792 (76.6)	1,470 (71.2)	1,157 (56.0)
Sex						
Male	10.3	8.6	6.1	1,774 (77.7)	1,510 (73.4)	1,178 (57.3)
Female	9.9	8.3	5.8	1,436 (76.3)	1,210 (71.0)	963 (56.5)
Head of household education						
Less than high school diploma	9.4	7.7	5.4	1,490 (74.7)	1,282 (69.3)	993 (53.7)
High school diploma	10.2	8.2	6.0	1,666 (78.5)	1,337 (72.8)	1,045 (56.9)
More than high school diploma	10.3	8.8	6.2	1,618 (76.9)	1,412 (73.1)	1,112 (57.6)
Household income						
<185% federal poverty level	9.8	8.0	5.7	1,579 (76.5)	1,330 (71.7)	1,043 (56.2)
185%–350% federal poverty level	10.0	8.7	6.1	1,618 (78.4)	1,408 (72.9)	1,092 (56.6)
>350% federal poverty level	10.5	9.0	6.3	1,654 (76.7)	1,407 (73.1)	1,113 (57.8)
Race/ethnicity						
Mexican American	9.5	7.7	5.5	1,489 (73.1)	1,290 (70.4)	994 (54.2)
White non-Hispanic	10.4	8.9	6.2	1,682 (78.9)	1,410 (74.6)	1,096 (58.0)
Black non-Hispanic	9.6	8.2	6.2	1,564 (76.4)	1,369 (71.4)	1,134 (59.2)
Saturated fat, g/day						
All children, 2–18 years				22.6 (71.1)	20.5 (61.3)	14.5 (43.4)
Age group						
2–5 years				18.1 (71.3)	16.2 (61.4)	10.4 (39.5)
6–11 years				22.8 (71.8)	21.9 (63.1)	16.1 (46.5)
12–18 years				24.9 (70.2)	21.5 (59.6)	15.3 (42.3)
Sex						
Male				25.0 (71.9)	22.6 (62.8)	16.0 (44.4)
Female				20.2 (70.1)	18.3 (59.9)	13.0 (42.6)
Head of household education						
Less than high school diploma				21.1 (70.0)	19.3 (60.8)	13.6 (42.8)
High school diploma				23.4 (73.1)	19.5 (63.4)	13.7 (44.6)
More than high school diploma				22.7 (70.4)	21.3 (61.0)	15.1 (43.3)
Household income						
<185% federal poverty level				22.3 (71.3)	19.3 (62.2)	13.8 (44.5)
185%–350% federal poverty level				22.4 (72.5)	21.6 (61.8)	15.1 (43.1)
>350% federal poverty level				23.4 (69.8)	21.5 (60.2)	15.2 (42.7)
Race/ethnicity						
Mexican American				20.5 (68.0)	19.0 (60.4)	13.5 (42.8)
White non-Hispanic				23.9 (72.2)	21.7 (62.4)	15.1 (43.3)
Black non-Hispanic				21.2 (72.0)	18.6 (63.8)	14.3 (49.1)
Total sugar, g/day						
All children, 2–18 years				88.8 (93.9)	64.2 (90)	58.8 (82.4)
Age group						
2–5 years				57.7 (92.4)	41.2 (86.9)	38.3 (80.7)
6–11 years				88.1 (94.5)	65.8 (90.5)	61.0 (83.9)

(continued on next page)

Table 3. Nutrient Intake Deriving From Junk Food Sources Overall and by Demographic Subgroup (*continued*)

Variable	Junk food items, n/d			Per capita intake from junk food		
	2003–2006	2013–2016	2013–2016 ^a	2003–2006 Mean intake (% total intake)	2013–2016 Mean intake (% total intake)	2013–2016 ^a Mean intake (% total intake)
12–18 years				105.9 (94.2)	74.7 (91.2)	67.6 (82.5)
Sex						
Male				99.9 (94.2)	71.4 (90.5)	65.4 (82.9)
Female				77.1 (93.6)	56.7 (89.6)	52.0 (82.2)
Head of household education						
Less than high school diploma				80.3 (94.2)	59.9 (89.5)	54.2 (80.9)
High school diploma				94.9 (94.5)	65.0 (90.8)	58.9 (82.2)
More than high school diploma				88.8 (93.5)	65.8 (89.9)	60.8 (83.0)
Household income						
<185% federal poverty level				85.5 (94.4)	62.8 (89.8)	57.8 (82.6)
185%–350% federal poverty level				92.6 (93.7)	66.3 (89.8)	59.5 (80.5)
>350% federal poverty level				90.8 (93.5)	65.1 (90.2)	60.0 (83.2)
Race/ethnicity						
Mexican American				79.8 (94.7)	54.4 (90.1)	50.2 (83.1)
White non-Hispanic				93.4 (93.9)	67.9 (90.4)	61.1 (81.4)
Black non-Hispanic				87.1 (94.5)	68.3 (90.1)	64.2 (84.7)
Mean sodium, mg/day						
All children, 2–18 years				2,306 (72.1)	2,044 (67.1)	1,681 (55.2)
Age group						
2–5 years				1,705 (70.8)	1,523 (67.9)	1,227 (54.7)
6–11 years				2,296 (73.0)	2,096 (68.5)	1,771 (57.9)
12–18 years				2,630 (72.0)	2,269 (65.6)	1,842 (53.3)
Sex						
Male				2,548 (73.2)	2,286 (68.6)	1,866 (56.0)
Female				2,050 (70.9)	1,794 (65.6)	1,491 (54.5)
Head of household education						
Less than high school diploma				2,078 (69.1)	1,939 (63.9)	1,591 (52.4)
High school diploma				2,394 (74.0)	2,023 (67.4)	1,662 (55.4)
More than high school diploma				2,337 (72.0)	2,099 (68.2)	1,729 (56.2)
Household income						
<185% federal poverty level				2,218 (71.0)	1,998 (66.1)	1,647 (54.5)
185%–350% federal poverty level				2,306 (73.3)	2,117 (68.2)	1,735 (55.9)
>350% federal poverty level				2,445 (72.8)	2,081 (68.6)	1,713 (56.5)
Race/ethnicity						
Mexican American				2,049 (67.4)	1,983 (65.4)	1,605 (52.9)
White non-Hispanic				2,423 (74.3)	2,102 (70)	1,716 (57.2)
Black non-Hispanic				2,277 (71.1)	2,061 (65.5)	1,793 (57.0)

Note: Boldface indicates statistical significance ($p < 0.05$).

Data from NHANES 2003–2004, NHANES 2005–2006, NHANES 2013–2014, and NHANES 2015–2016. Results have been weighted to be nationally representative. The 100% of participants consumed products considered junk food. Results for other Hispanics and Other Race not shown. Junk food is defined by utilizing the Chilean nutrition profile model Phase 2 criteria for nonbasic food groups containing excessive added sugar, salt, saturated fat or energy density in addition to foods classified as ultraprocessed under NOVA.

^aChilean criteria plus NOVA ultraprocessed foods.

n/d, number per day; NHANES, National Health and Nutrition Examination Survey.

foods for ready-to-eat cereals (70–58 kcal/day, $p < 0.01$, [Appendix Table 3](#), available online). Significant increases in mean total sugar intake from junk foods were seen in sandwiches, burgers, and pizzas and salty snacks ($p < 0.01$ for both) ([Appendix Table 4](#), available online),

and a large increase in mean sodium intake deriving from junk foods in sandwiches, burgers, and pizzas ($p < 0.01$) ([Appendix Table 5](#), available online).

Mean calories deriving from junk food sources in burgers, sandwiches, and pizzas increased in some subgroups

Figure 1. Nutrient intake from junk food sources, 2003–2016. (A) Energy intake (kcal/day) from junk food sources. (B) Sugar intake (g/day) from junk food sources. (C) Saturated fat intake (g/day) from junk food source. (D) Sodium intake (mg/day) from junk food sources.

between 2003 and 2016: aged 2–5 years (113–151 kcal/day, $p<0.01$), aged 6–11 years (220–275 kcal/day, $p<0.01$), the lowest education group (214–288 kcal/day, $p<0.01$), Mexican Americans (231–333 kcal/day, $p<0.01$), and black non-Hispanics (215–253 kcal/day, $p<0.01$) (Appendix Table 3, available online).

The overall differences in estimates without the addition of the ingredient criteria were driven by a few key categories. For example, calorie intake from juices decreased from 38 kcal/day to 1 kcal/day with the addition of the ingredient criteria (Appendix Table 6, available online). Similarly, mean sodium intake from cheese and cheese products decreased from 104 mg/day to 48 mg/day and mean calorie intake from 39 kcal/day to 11 kcal/day. Sandwiches, burgers, and pizzas also had a decrease in mean calorie contributions from 260 kcal/day to 230 kcal/day and mean sodium from 582 mg/day to 513 mg/day. For categories such as ready-to-eat cereals and confectionery, results remained the same with and without the addition of the ingredient criteria.

DISCUSSION

This study revealed that during a 14-year period, the proportion of reported foods consumed by U.S. children and adolescents that were considered junk foods decreased by about 10 percentage points. Despite this

decrease, >70% of total calories and >90% of total sugar intake derived from junk foods in 2013–2016. Even with the addition of the ingredient criteria used to identify junk foods in NHANES 2013–2016, 57% of energy, 82% of total sugar, 55% of sodium, and 43% of saturated fat consumed by U.S. children and adolescents still derived from junk food sources. This is in line with previous research showing that the U.S. population has a high intake of foods high in added sugar and solid fats⁴⁵ and with research in U.S. children from 2003 to 2010 showing that although total calorie intake from junk foods declined over time, intake was still unacceptably high.⁴⁶ It is also in line with research from other Western countries showing that a large proportion of energy intake derives from foods generally considered less healthy.^{45,47}

No examined subgroup had <69% of calories deriving from junk foods in 2013–2016, an interesting finding considering that studies from various Western countries show that disparities exist between racial or ethnic and education groups in the types of foods consumed, with lower socioeconomic groups often having a higher intake of unhealthy foods.^{34,48,49} One previous study observed that black non-Hispanic and Hispanic households with children purchased less highly processed foods from stores than white non-Hispanics, although this study found that black non-Hispanics purchased a higher amount of sugar.⁵⁰

It is concerning that such a large proportion of U.S. children and adolescent total sugar intake derives from junk foods. The American Heart Association recommends that U.S. children and adolescents consume <10% of daily calories from sugar sources. With the finding that U.S. children in 2013–2016 were consuming on average at least 82% (59 g or 236 kcal) of total sugar per day from junk food sources, it is clear that there is scope for improvement.

The Chilean regulation was implemented in 2016. Although limited research exists as to the effectiveness of the regulation (owing to its infancy), early research has found that the food marketing regulation can be effective at reducing the use of child-directed marketing for unhealthy products, with 1 study finding that breakfast cereals using child-directed strategies decreased from 43% before implementation to 15% after implementation.⁵¹ In the U.S., a number of country-wide and state-based policies have been implemented, attempting to reduce the purchase and hence consumption of less-healthy foods for children and adolescents. For example, some major food and beverage companies previously signed up to the Better Business Bureau's Children's Food and Beverage Advertising Initiative and pledged that they will only market healthier foods to children and adolescents.⁵² Despite this high-level commitment, research into the scheme has demonstrated that the pledge is often not upheld, with 1 study reporting that 88% of Children's Food and Beverage Advertising Initiative member company advertisements seen on TV by children promoted products high in saturated fat, sugar, or sodium.⁵³ This, along with findings from this study, lend support to exploring the implementation of established schemes restricting the marketing of foods to children, such as Chile's criteria.

Limitations

This analysis had some limitations. Reported dietary data have limitations in misreporting and can vary by age, sex, and race or ethnicity.⁵⁴ Despite each survey being linked to the same Food and Nutrient Database for Dietary Studies USDA food composition table, there may have been changes in nutrient composition on the basis of different assay techniques that cannot be accounted for. One limitation was that only the nutrient criteria component of the Chilean regulation, not the ingredient component, was used for the trends analysis. Data for ingredients were not available for NHANES 2003–2006; however, data were available for 2013–2016 and revealed that mean calorie intake from junk foods was overestimated by approximately 28% when only the nutrient criteria, not the added ingredient criteria, were used. Categories like cheese and cheese products and juices had a substantial decrease in calories deriving from

junk foods with the addition of the added ingredient criteria; however, other categories like confectionery and ready-to-eat cereals showed no change. What this shows is that by relying solely on nutrient criteria, products such as juices that do not meet the nutrient criteria owing to higher levels of sugar would not be considered junk food under the Chilean regulation as the sugar is from natural (not added) sugar sources.

CONCLUSIONS

Despite noted reductions over 14 years, children and adolescents in the U.S. are still getting a large proportion of calories from junk foods, creating a trajectory for long-term weight gain and cardiometabolic problems. Between 56% and 70% of total calories, 43% and 61% of saturated fat intake, 82% and 90% of sugar intake, and 55% and 67% of sodium intake among U.S. children and adolescents derived from junk foods in 2013–2016. With reports from the Institute of Medicine⁵⁵ and Federal Trade Commission⁵⁶ suggesting that stronger nutrition standards for foods and beverages marketed to children are needed, the implementation of a scheme, such as the Chilean criteria, is critical to ensure U.S. children are not exposed to products that are high in energy, added sugar, saturated fat, and sodium. Future research should examine how other factors influence junk food intake, such as social and family aspects, exposure to unhealthy food marketing, screen time, and physical activity levels. This study should be considered as 1 example to help guide policy regulations regarding the foods and beverages that are accessible in schools and marketed to children, adolescents, and their caregivers.

ACKNOWLEDGMENTS

The authors thank Karen Ritter for exceptional assistance with data management. The authors had exceptional assistance from Euridice Martinez of University of São Paulo, whose software allowed for calculating all the Chilean ingredient criteria for 2013–2016.

Funding for this work comes primarily from Arnold Ventures, with additional support from the Carolina Population Center NIH grant [P2C HD050924](https://doi.org/10.1016/j.amepre.2020.01.023).

Elizabeth, Barry, and Shu Wen designed and conducted this research. Elizabeth analyzed data and drafted the paper. Elizabeth, Shu Wen, and Barry had joint primary responsibility for final content.

No financial disclosures were reported by the authors of this paper.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at <https://doi.org/10.1016/j.amepre.2020.01.023>.

REFERENCES

1. CDC. Childhood obesity facts. Updated 2018. www.cdc.gov/healthy-schools/obesity/facts.htm. Accessed July 20, 2019.
2. Singh AS, Mulder C, Twisk JW, van Mechelen W, Chinapaw MJ. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev*. 2008;9(5):474–488. <https://doi.org/10.1111/j.1467-789X.2008.00475.x>.
3. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. Racial differences in the tracking of childhood BMI to adulthood. *Obes Res*. 2005;13(5):928–935. <https://doi.org/10.1038/oby.2005.107>.
4. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes*. 2006;1(1):11–25. <https://doi.org/10.1080/17477160600586747>.
5. Serdula MK, Ivery D, Coates RJ, Freedman DS, Williamson DF, Byers T. Do obese children become obese adults? A review of the literature. *Prev Med*. 1993;22(2):167–177. <https://doi.org/10.1006/pmed.1993.1014>.
6. Power C, Lake JK, Cole TJ. Review: measurement and long-term health risks of child and adolescent fatness. *Int J Obes Relat Metab Disord*. 1997;21(7):507–526. <https://doi.org/10.1038/sj.ijo.0800454>.
7. Harvard School of Public Health. Child obesity: too many kids are too heavy, too young. www.hsph.harvard.edu/obesity-prevention-source/obesity-trends/global-obesity-trends-in-children/. Accessed August 13, 2019.
8. WHO. Childhood overweight and obesity. www.who.int/dietphysicalactivity/childhood/en/. Accessed August 13, 2019.
9. Sun SS, Liang R, Huang TTK, et al. Childhood obesity predicts adult metabolic syndrome: the Fels Longitudinal Study. *J Pediatr*. 2008;152(2):191–200. <https://doi.org/10.1016/j.jpeds.2007.07.055>.
10. Must A, Strauss RS. Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord*. 1999;23(suppl 2):S2–S11. <https://doi.org/10.1038/sj.ijo.0800852>.
11. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes (Lond)*. 2011;35(7):891–898. <https://doi.org/10.1038/sj.ijo.2010.222>.
12. Olshansky SJ, Passaro DJ, Hershow RC, et al. A potential decline in life expectancy in the United States in the 21st century. *N Engl J Med*. 2005;352(11):1138–1145. <https://doi.org/10.1056/NEJMs043743>.
13. Daniels SR. Complications of obesity in children and adolescents. *Int J Obes (Lond)*. 2009;33(suppl 1):S60–S65. <https://doi.org/10.1038/ijo.2009.20>.
14. WHO. Consideration of the evidence on childhood obesity for the Commission on ending childhood obesity: report of the ad hoc working group on science and evidence for ending childhood obesity, Geneva, Switzerland. WHO. <https://apps.who.int/iris/handle/10665/206549>. Accessed August 13, 2019.
15. Duffey KJ, Gordon-Larsen P, Ayala GX, Popkin BM. Birthplace is associated with more adverse dietary profiles for U.S.-born than for foreign-born Latino adults. *J Nutr*. 2008;138(12):2428–2435. <https://doi.org/10.3945/jn.108.097105>.
16. Duffey KJ, Popkin BM. Causes of increased energy intake among children in the U.S., 1977–2010. *Am J Prev Med*. 2013;44(2):e1–e8. <https://doi.org/10.1016/j.amepre.2012.10.011>.
17. WHO. Report of the Commission on Ending Childhood Obesity. www.who.int/end-childhood-obesity/publications/echo-report/en/. Published 2016. Accessed August 13, 2019.
18. Frederick CB, Snellman K, Putnam RD. Increasing socioeconomic disparities in adolescent obesity. *Proc Natl Acad Sci U S A*. 2014;111(4):1338–1342. <https://doi.org/10.1073/pnas.1321355110>.
19. Institute of Medicine. *Early Childhood Obesity Prevention Policies*. Washington, DC: The National Academies Press, 2011.
20. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA*. 2014;311(8):806–814. <https://doi.org/10.1001/jama.2014.732>.
21. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the United States, 1988–1994 through 2013–2014. *JAMA*. 2016;315(21):2292–2299. <https://doi.org/10.1001/jama.2016.6361>.
22. Ng SW, Slining MM, Popkin BM. Turning point for US diets? Recessionary effects or behavioral shifts in foods purchased and consumed. *Am J Clin Nutr*. 2014;99(3):609–616. <https://doi.org/10.3945/ajcn.113.072892>.
23. Eicher-Miller HA, Fulgoni VL 3rd, Keast DR. Contributions of processed foods to dietary intake in the U.S. from 2003–2008: a report of the Food and Nutrition Science Solutions Joint Task Force of the Academy of Nutrition and Dietetics, American Society for Nutrition, Institute of Food Technologists, and International Food Information Council. *J Nutr*. 2012;142(11):2065S–2072S. <https://doi.org/10.3945/jn.112.164442>.
24. Martínez Steele E, Baraldi LG, Louzada ML, Moubarac JC, Mozafarian D, Monteiro CA. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. *BMJ Open*. 2016;6(3):e009892. <https://doi.org/10.1136/bmjopen-2015-009892>.
25. Martínez Steele EM, Popkin BM, Swinburn B, Monteiro CA. The share of ultra-processed foods and the overall nutritional quality of diets in the US: evidence from a nationally representative cross-sectional study. *Popul Health Metr*. 2017;15(1):6. <https://doi.org/10.1186/s12963-017-0119-3>.
26. Poti JM, Mendez MA, Ng SW, Popkin BM. Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by U.S. households? *Am J Clin Nutr*. 2015;101(6):1251–1262. <https://doi.org/10.3945/ajcn.114.100925>.
27. Hall KD, Ayuketah A, Brychta R, et al. Ultra-processed diets cause excess calorie intake and weight gain: a one-month inpatient randomized controlled trial of ad libitum food intake. *Cell Metab*. 2019;30(1):67–77.e3. <https://doi.org/10.1016/j.cmet.2019.05.008>.
28. Costa Louzada ML, Martins AP, Canella DS, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. *Rev Saúde Pública*. 2015;49:38. <https://doi.org/10.1590/S0034-8910.2015049006132>.
29. Louzada ML, Baraldi LG, Steele EM, et al. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Prev Med*. 2015;81:9–15. <https://doi.org/10.1016/j.ypmed.2015.07.018>.
30. Canhada SL, Luft VC, Giatti L, et al. Ultra-processed foods, incident overweight and obesity, and longitudinal changes in weight and waist circumference: the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *Public Health Nutr*. 2020;23(6):1076–1086. <https://doi.org/10.1017/s1368980019002854>.
31. Rico-Campà A, Martínez-González MA, Alvarez-Alvarez I, et al. Association between consumption of ultra-processed foods and all cause mortality: SUN prospective cohort study. *BMJ*. 2019;365:11949. <https://doi.org/10.1136/bmj.11949>.
32. Kirkpatrick SI, Dodd KW, Reedy J, Krebs-Smith SM. Income and race/ethnicity are associated with adherence to food-based dietary guidance among U.S. adults and children. *J Acad Nutr Diet*. 2012;112(5):624–635.e6. <https://doi.org/10.1016/j.jand.2011.11.012>.
33. Hiza HA, Casavale KO, Guenther PM, Davis CA. Diet quality of Americans differs by age, sex, race/ethnicity, income, and education level. *J Acad Nutr Diet*. 2013;113(2):297–306. <https://doi.org/10.1016/j.jand.2012.08.011>.
34. Dunford EK, Popkin BM. 37 year snacking trends for U.S. children 1977–2014. *Pediatr Obes*. 2018;13(4):247–255. <https://doi.org/10.1111/ijpo.12220>.
35. Batis C, Rivera JA, Popkin BM, Taillie LS. First-year evaluation of Mexico's tax on nonessential energy-dense foods: an observational study. *PLoS Med*. 2016;13(7):e1002057. <https://doi.org/10.1371/journal.pmed.1002057>.
36. Holt E. Hungary to introduce broad range of fat taxes. *Lancet*. 2011;378(9793):755. [https://doi.org/10.1016/s0140-6736\(11\)61359-7](https://doi.org/10.1016/s0140-6736(11)61359-7).

37. World Cancer Research Fund International. Nourishing database. www.wcrf.org/int/policy/nourishing-database. Accessed August 13, 2019.
38. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN decade of nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr*. 2018;21(1):5–17. <https://doi.org/10.1017/S1368980017000234>.
39. Labonté MÈ, Poon T, Gladanac B, et al. Nutrient profile models with applications in government-led nutrition policies aimed at health promotion and noncommunicable disease prevention: a systematic review. *Adv Nutr*. 2018;9(6):741–788. <https://doi.org/10.1093/advances/nmy045>.
40. Rodríguez Osiac L, Pizarro Quevedo T. Ley de Etiquetado y Publicidad de Alimentos: Chile innovando en nutrición pública una vez más [Law of Food Labelling and Advertising: Chile innovating in public nutrition once again]. *Rev Chil Pediatr*. 2018;89(5):579–581. <https://doi.org/10.4067/S0370-41062018005000806>.
41. Corvalán C, Reyes M, Garmendia ML, Uauy R. Structural responses to the obesity and non-communicable diseases epidemic: update on the Chilean law of food labelling and advertising. *Obes Rev*. 2019;20(3):367–374. <https://doi.org/10.1111/obr.12802>.
42. Endevelt R, Grotto I, Sheffer R, et al. Policy and practice - regulatory measures to improve the built nutrition environment for prevention of obesity and related morbidity in Israel. *Public Health Panorama*. 2017;3(4):537–820.
43. Perloff BP, Rizek RL, Haytowitz DB, Reid PR. Dietary intake methodology. II. USDA's Nutrient Data Base for Nationwide Dietary Intake Surveys. *J Nutr*. 1990;120(suppl 11):1530–1534. https://doi.org/10.1093/jn/120.suppl_11.1530.
44. Popkin BM, Haines PS, Siega-riz AM. Dietary patterns and trends in the United States: the UNC-CH approach. *Appetite*. 1999;32(1):8–14. <https://doi.org/10.1006/appe.1998.0190>.
45. Reedy J, Krebs-Smith SM. Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *J Am Diet Assoc*. 2010;110(10):1477–1484. <https://doi.org/10.1016/j.jada.2010.07.010>.
46. Bleich SN, Wolfson JA. Trends in SSBs and snack consumption among children by age, body weight, and race/ethnicity. *Obesity (Silver Spring)*. 2015;23(5):1039–1046. <https://doi.org/10.1002/oby.21050>.
47. Mercille G, Receveur O, Macaulay AC. Are snacking patterns associated with risk of overweight among Kahnawake schoolchildren? *Public Health Nutr*. 2010;13(2):163–171. <https://doi.org/10.1017/S1368980009990711>.
48. Fernández-Alvira JM, Böhnhorst C, Bammann K, et al. Prospective associations between socio-economic status and dietary patterns in European children: the Identification and Prevention of Dietary- and Lifestyle-induced Health Effects in Children and Infants (IDEFICS) Study. *Br J Nutr*. 2015;113(3):517–525. <https://doi.org/10.1017/S0007114514003663>.
49. Gates A, Skinner K, Gates M. The diets of school-aged Aboriginal youths in Canada: a systematic review of the literature. *J Hum Nutr Diet*. 2015;28(3):246–261. <https://doi.org/10.1111/jhn.12246>.
50. Poti JM, Mendez MA, Ng SW, Popkin BM. Highly processed and ready-to-eat packaged food and beverage purchases differ by race/ethnicity among U.S. households. *J Nutr*. 2016;146(9):1722–1730. <https://doi.org/10.3945/jn.116.230441>.
51. Mediano Stoltze F, Reyes M, Smith TL, Correa T, Corvalán C, Carpenter FRD. Prevalence of child-directed marketing on breakfast cereal packages before and after Chile's food marketing law: a pre- and post-quantitative content analysis. *Int J Environ Res Public Health*. 2019;16(22):4501. <https://doi.org/10.3390/ijerph16224501>.
52. Better Business Bureau. Children's food and beverage advertising initiative. www.bbb.org/council/the-national-partner-program/national-advertising-review-services/childrens-food-and-beverage-advertising-initiative/. Accessed December 2, 2019.
53. Powell LM, Harris JL, Fox T. Food marketing expenditures aimed at youth: putting the numbers in context. *Am J Prev Med*. 2013;45(4):453–461. <https://doi.org/10.1016/j.amepre.2013.06.003>.
54. Livingstone MB, Robson PJ, Wallace JM. Issues in dietary intake assessment of children and adolescents. *Br J Nutr*. 2004;92(suppl 2):S213–S222. <https://doi.org/10.1079/bjn20041169>.
55. Institute of Medicine. Food marketing to children and youth: threat or opportunity?. www.nationalacademies.org/hmd/Reports/2005/Food-Marketing-to-Children-and-Youth-Threat-or-Opportunity.aspx. Published 2005. Accessed December 2, 2019.
56. Federal Trade Commission. A review of food marketing to children and adolescents. www.ftc.gov/sites/default/files/documents/reports/review-food-marketing-children-and-adolescents-follow-report/121221food-marketingreport.pdf. Published 2012. Accessed December 2, 2019.