

Original Research Article

Cross-sectional associations of Special Supplemental Nutrition Program for Women, Infants, and Children benefit redemption and diet among children ages 1–4 years in California

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A B S T R A C T

Background: The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides supplemental healthy foods to children aged <5 y in low-income households.

Objectives: The objectives of this study were to characterize WIC benefit redemption, identify associations between benefit redemption and child dietary intake, and whether child age modifies these associations.

Methods: The cross-sectional 2023 California Statewide WIC Survey, conducted with caregivers of WIC-participating children aged 1–4 y, was analyzed for this study. Included children had complete benefit redemption data, a complete National Health and Nutrition Examination Survey Dietary Screener Questionnaire (DSQ), and complete covariate data (weighted $n = 2244$). Monthly household category-specific benefit redemption percentage was averaged across 6 and 3 mo preceding survey completion. Associations between household redemption and child dietary intake (servings or amount/day) were assessed with multivariable linear regression and expressed as estimates and 95% confidence intervals (CI).

Results: Twenty-five percent higher redemption of breakfast cereal, whole grain bread, yogurt and whole milk in the 6 mo prior to the survey were associated with higher child intake frequency for cereal (0.02 servings/d; 95% CI: 0.00, 0.04), whole grain bread (0.02 servings/d; 95% CI: 0.00, 0.03), yogurt (0.04 servings/d; 95% CI: 0.02, 0.06), and whole milk (0.09 servings/d; 95% CI: 0.01, 0.16). Significant effect modification by child age (12 to <24 mo, 24–59 mo) was found for redemption of cheese/tofu and 100% juice (P -interaction = 0.02 and 0.001, respectively), and 25% higher redemption of these benefits were associated with lower intake frequency for cheese (−0.05 servings/d; 95% CI: −0.09, −0.02) and higher intake frequency for juice (0.12 servings/d; 95% CI: 0.06, 0.18), but only among children ages 12 to <24 mo.

Conclusions: Higher redemption was associated with higher child intake of select WIC foods. Pairing the promotion of benefit redemption among program participants with nutrition education efforts may enhance dietary impacts of WIC participation.

Keywords: WIC, benefit redemption, child diet, nutrition assistance, cross-sectional, California, WIC food package

Introduction

Low diet quality is common among young children in the United States [1]. Studies using data from the longitudinal Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Infant and Toddler Feeding Practices Study-2 have reported average diet quality to be low among infants, toddlers, and children aged ≤3 y [2], with diet quality remaining low at age 5 y [3]. Child diets in the United States exhibited small improvements in some domains from 1999 to 2016 [4], but low diet quality in early childhood continues to

contribute to risk of adverse health outcomes, including obesity [5] and chronic diseases [6]. Diet quality patterns persist through childhood [7] and into adulthood [8], contributing to chronic disease risk across the life course [9].

WIC is a nutrition assistance program of the United States federal government, serving pregnant and postpartum women, and their infants and children aged ≤5 y, who live in low-income households [10]. The WIC program serves over 6 million participants every month [11] and reaches an estimated more than half of the population eligible to participate [12]. The program provides 4 core services, which include

Abbreviations: DSQ, Dietary Screener Questionnaire; FV, fruits and vegetables; SNAP, Supplemental Nutrition Assistance Program; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

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nutrition education, breastfeeding support, health and social service referrals, and supplemental healthy foods (i.e., the WIC food package) [10]. WIC food packages were modified in 2009 to align with the 2005 Dietary Guidelines for Americans [13]. The WIC food packages for children are tailored to support the age-specific nutritional needs of children in addition to both special dietary considerations and the amount of maternally reported breastfeeding during infancy [14]. Child diet quality improved among WIC-participating children following the food package modifications in 2009 [15,16], and WIC-eligible foods represent substantial proportions of the diets of participating children [17].

Disparities in diet quality between children in low-income households and children in high-income households are particularly acute for foods purchased at grocery stores [18]. The healthy foods provided in WIC food packages therefore have the potential to improve child diets throughout early childhood given the wide reach of the program into low-income households [7,8]. The adoption of electronic benefit transfer systems for purchasing WIC foods at approved vendors [19] provides an opportunity to evaluate the association between WIC benefit redemption (i.e., actual purchases) and child diet. This study was conducted to evaluate the associations between WIC benefit redemption and child diet among respondents to the 2023 California Statewide WIC Survey. It was hypothesized that higher redemption of WIC-issued foods and beverages would be associated with higher child intake of those foods and beverages.

Methods

Sample and setting

This study used the data of 2282 respondents to the 2023 California Statewide WIC Survey, administered between March 27 and August 1, 2023 (weighted $N = 2244$). Survey-eligible households were a random sample of 10,000 WIC-participating households in California in January 2023, with a nonfoster child aged 1–4 y participating in the program, and able to complete an interview in English or Spanish. This study was administered by 2 methods. Preapproach letters were mailed in 7 batches of 1000 to eligible households, with a final batch of 140 letters mailed to ensure the target sample size of 3000 was reached. The sample size of 3000 was selected because it was calculated to be sufficient to assess relationships between WIC services and child diet. Preapproach letters indicated that the household would be contacted by phone to complete the survey and included a quick response code and access key to allow the household to complete the survey online if they preferred that method. In total, 3000 surveys were completed (2129 via telephone and 871 via the internet). Respondents received a 10-United States dollar incentive for completing the survey, and the response rate (calculated by dividing the number of completed surveys by the sum of the number of completed surveys and the number of nonresponses due to refusals, call blocking, and language barriers plus the proportion of survey eligibility among those who agreed to complete survey (0.98) multiplied by the number of nonresponses due to call blocking and unavailability for the full study period) was 46% (Supplemental Figure 1). Of the 3000 respondents to the survey, exclusions were made sequentially for incomplete dietary outcome data ($n = 526$), missing administrative data on benefit redemption ($n = 7$), and incomplete covariate information ($n = 185$) (Supplemental Figure 1). The California Health and Human Services Agency Committee for the Protection of Human Subjects, acting as an Institutional Review Board, approved this study. Oral informed consent was obtained from respondents to the telephone survey, and written informed consent was obtained from respondents to the internet survey.

WIC administrative data

Household WIC benefit redemption was the primary exposure of interest for this study. WIC benefits are issued and redeemed in categories [for this study including 14 separate categories: cheese/tofu, eggs, breakfast cereal, legumes, infant cereal, infant fruits and vegetables (FV), infant meats, bread/whole grains, FV, infant formula, yogurt, whole milk, reduced fat milk, and 100% juice]. WIC food benefits in California are issued and redeemed on a rolling monthly basis, and unredeemed benefits expire at the end of the obligation month (i.e., the 1-mo period in which they must be redeemed). Category-specific redemption percentages were calculated monthly for each family by dividing the amount redeemed by the amount issued. Category-specific percent redemption was then summarized as the average percent redemption for months with nonmissing category-specific issuance across the 12, 6, and 3 mo before survey completion. An overall percent redemption was then calculated for each family by calculating the average across all food benefit categories that the family was issued that month, and this was also averaged across the 12, 6, and 3 mo before the completion of the survey. Owing to the similarity in average category-specific redemption across the 3 periods, the 6 and 3 mo before survey completion were chosen for subsequent analyses given the greater proximity to the dietary assessment.

Child diet

Child diet was assessed with the National Health and Nutrition Examination Survey (NHANES) Dietary Screener Questionnaire (DSQ) [20]. The NHANES DSQ is a tool for dietary intake measurement among United States populations, which is considered to be valid tool for assessment of child diet given associations with food intakes assessed with dietary recalls [21,22]. The DSQ was used to collect the frequency (in the preceding month) of child intake of cereal (frequency and type), milk (frequency and type), soda, 100% juice, water, sweetened fruit flavored drinks, sports or energy drinks, fruit, green leafy vegetables, fried potatoes, cooked dried beans, other vegetables, cheese, whole grain bread, brown rice, corn/flour tortillas, peanut butter, canned fish packed in water, and yogurt. All frequencies were converted to servings per day, and estimated intake of FV (cups per day) was calculated by child age and sex using National Cancer Institute algorithms [21,23]. For this study, FV intake included 100% juice, legumes and fried potatoes, and legume intake included cooked dried beans and peanut butter.

Covariates

Other variables available for this analysis included the child's sex (male/female), age at the time of the survey (12–23, 24–35, 36–47, and 48–60 mo), and child race, ethnicity, and caregiver language preference (Asian, Black, Hispanic Spanish-speaking, Hispanic English-speaking, White, and other); whether the adult completing the survey was the child's mother (yes/no), the adult's educational attainment (completed less than high school, completed high school, completed more than high school), and current employment status (working for pay and not working for pay); and household size (continuous), number of children aged <5 y in the household (continuous), number of children aged 5 to <18 y in the household (continuous), number of household WIC participants (continuous), household food security assessed with the United States Department of Agriculture (USDA) 6-item Household Food Security Survey Module (secure and insecure) [24], and Supplemental Nutrition Assistance Program (SNAP) participation (yes/no). Child age (12 to <24 mo and 24–60 mo) was hypothesized to be a potential effect modifier of the association between WIC benefit redemption and child diet.

Statistical analysis

To ensure that survey responses were representative of the study-eligible population, poststratification weights were calculated [25] as the ratio of the proportion of children in a joint covariate stratum in the study-eligible population (i.e., those sent preapproach letters) to the proportion in that joint covariate stratum who responded to the survey. Unique weights were calculated for strata defined by every combination of the following covariates: race, ethnicity, and language preference, California census region, child age category, and household WIC benefit redemption class. WIC benefit redemption class was determined with latent profile analysis, evaluating solutions of 2–8 latent classes. Entropy was >0.9 for all evaluated models. The 6-class solution was identified as the preferred solution based on lower Bayesian Information Criterion values than the 5-class solution (both standard and sample size adjusted) and a statistically significant adjusted Lo-Mendell Rubin test ($P < 0.001$) compared with the 5-class model [26]. The 6-class model was selected over the 7- or 8-class models due to the identification of ≥ 1 low-prevalence class (representing $<5\%$ of the sample) in the 7- and 8-class solutions. Category-specific WIC benefit redemption was then summarized in latent profile groups with means and SDs, and differences in means were tested with analysis of variance F tests (Supplemental Table 1). Weights were calculated separately for telephone and web-based survey respondents. Resulting weights (mean: 0.98; SD: 0.62; minimum, maximum: 0.17, 8.11) were incorporated into all statistical analyses and regression models to standardize survey responses to the study-eligible population (Supplemental Table 2).

Respondent characteristics were summarized overall and in categories defined by method of survey completion (telephone and internet). Frequencies and proportions were used for categorical variables. Means and SDs were used for continuous variables.

The distribution of WIC benefit redemption percent in each benefit category was summarized with the prevalence of zero redemption and with the median and IQR (25th percentile, 75th percentile), and the distribution of child dietary intake (frequency or amount) was summarized as mean (SD). Given the supplemental nature of WIC food packages, with WIC food benefits reported to provide up to between 19% (vegetables) and 85% (milk) of recommended dietary intake for children aged 2–5 y [1,27], associations between redemption and child diet were estimated for each 25% higher redemption because this magnitude difference was thought to be plausibly related to meaningful differences in child diet (e.g., each additional 25% redemption of vegetables providing 0.07 cups/d of vegetables, each additional 25% redemption of milk providing 0.52 cups/d of milk). Estimates (95% CI) for associations between WIC benefit redemption percentage (continuous/linear) and child diet were assessed in linear regression models for child dietary intake. Only children from households with non-missing issuance for each specific food benefit were included in the regression model for that food benefit category. Higher-order polynomials (quadratic and cubic) for WIC benefit redemption were explored and removed from models due to nonsignificance. Child dietary intake was the dependent variable, and models included independent terms for category-specific benefit redemption percentage and survey method (web or telephone); child age, sex and race, ethnicity, and language preference; caregiver education and employment; household food insecurity, SNAP participation, household size, and number of WIC recipients in the household. A sensitivity analysis omitting adjustment for household food insecurity status was performed owing to uncertainty about its function as a confounder or

mediator of associations between benefit redemption and child diet. An additional set of models were analyzed, parameterized identically, with the addition of a 2-way interaction between category-specific benefit redemption percentage and child age category (12 to <24 mo and 24–60 mo) to allow for estimation of associations between benefit redemption and child diet in strata of child age. Whole milk and reduced fat milk were not included in analyses of effect modification by child age, as children 12 to <24 mo are issued only whole milk and children ≥ 24 mo are issued only reduced fat milk. Only food benefit categories issued to children aged 1–4 y and with a corresponding dietary intake item in the DSQ were assessed in regression models (cheese/tofu, legumes, whole grain bread, FV, yogurt, whole milk, reduced fat milk, and 100% juice).

Individuals with missing data on exposures, outcomes, or covariates were excluded from the analysis. Latent profile analysis was conducted using Mplus 8 [28], and all other analyses were conducted using SAS 9.4 (SAS Institute Inc). P values of <0.05 were considered statistically significant.

Results

Over 75% of the weighted sample ($N = 2244$) was Hispanic with either English language preference (46.0%) or Spanish language preference (31.7%) (Table 1). Approximately half of children were male (50.4%), and children were nearly evenly distributed among age categories (24.9%, 12 to <24 mo; 28.5%, 24 to <36 mo; 27.0%, 36 to <48 mo; and 19.7%, 48 to 60 mo). Race, ethnicity, and language preference differed between telephone and online respondents. Caregivers with educational attainment greater than high school were a larger proportion of online than telephone surveys (53.6% compared with 39.5%). Food insecure households were a larger proportion of online than telephone surveys (52.0% compared with 37.0%). Online respondents lived in households with fewer total individuals (4.30 compared with 4.59), more children aged <5 y (1.34 compared with 1.25 children), and with more WIC recipients (1.55 compared with 1.42 recipients) compared with telephone respondents. Mean total WIC benefit redemption percentage ranged from 53.79% for the 12 mo before survey completion to 54.78% for the 3 mo before survey completion.

Redemption of WIC foods varied broadly across categories (Table 2). Median redemption for categories in the 6 mo before survey completion ranged from 33.3% for yogurt and legumes to 75.0% for whole milk and 80.0% for FV. Median redemption was $\geq 50\%$ for cheese/tofu, eggs, FV, whole milk, reduced fat milk, and 100% juice.

Each 25% higher redemption of breakfast cereal, for the 6 and 3 mo before survey completion was associated with intakes of 0.02 (95% CI: 0.00, 0.04; $P = 0.02$) and 0.02 (95% CI: 0.01, 0.04; $P = 0.008$) more servings/d of cereal (Table 3), respectively. For the 6 mo before survey completion, each 25% higher redemption of whole grain bread was associated with intake of 0.02 more servings/d of whole grain bread (95% CI: 0.00, 0.03; $P = 0.02$). Each 25% higher redemption of yogurt, for the 6 and 3 mo before survey completion respectively, was associated with intakes of 0.04 (95% CI: 0.02, 0.06; $P < 0.0001$) and 0.04 (95% CI: 0.02, 0.05; $P < 0.0001$) more servings/d of yogurt, respectively. Each 25% higher redemption of whole milk, for the 6 and 3 mo before survey completion was associated with intakes of 0.09 (95% CI: 0.01, 0.16; $P = 0.02$) and 0.09 (95% CI: 0.00, 0.17; $P < 0.05$) more servings/d of milk, respectively. Each 25% higher redemption of 100% juice for the 3 mo before survey completion was associated with intake of 0.04 more servings/d juice (95% CI: 0.01, 0.07; $P = 0.02$). No

TABLE 1
Distribution of sample characteristics among respondents to the 2023 Statewide California WIC Survey, March–August 2023 (*N*, weighted = 2244).

Variable	Overall ¹ <i>N</i> = 2244	Online ¹ <i>n</i> = 385	Telephone ¹ <i>n</i> = 1859
Child characteristics			
Male, <i>n</i> (%)	1131 (50.4)	188 (48.8)	943 (50.7)
Race, ethnicity, and language preference, <i>n</i> (%)			
Asian	49 (2.2)	12 (3.1)	37 (2.0)
Black	112 (5.0)	13 (3.3)	100 (5.4)
Hispanic, EN	1032 (46.0)	204 (52.8)	828 (44.6)
Hispanic, SP	711 (31.7)	108 (28.0)	603 (32.4)
White	244 (10.9)	31 (8.1)	213 (11.5)
Other	96 (4.3)	18 (4.6)	78 (4.2)
Age (mo), <i>n</i> (%)			
12 to <24	559 (24.9)	102 (26.5)	457 (24.6)
24 to <36	639 (28.5)	116 (30.1)	523 (28.1)
36 to <48	605 (27.0)	90 (23.5)	515 (27.7)
≥48	442 (19.7)	77 (19.9)	365 (19.6)
Caregiver characteristics			
Mother completed survey, <i>n</i> (%)	2202 (98.1)	379 (98.5)	1822 (98.0)
Educational attainment, <i>n</i> (%)			
<Completed HS	449 (20.0)	51 (13.3)	397 (21.4)
Completed HS	855 (38.1)	127 (33.0)	728 (39.1)
>Completed HS	941 (41.9)	207 (53.6)	734 (39.5)
Currently employed, <i>n</i> (%)	1044 (46.5)	174 (45.2)	869 (46.8)
Household characteristics			
SNAP participation, <i>n</i> (%)	987 (44.0)	152 (39.4)	835 (44.9)
Food insecure, <i>n</i> (%)	888 (39.6)	200 (52.0)	687 (37.0)
Household size, mean ± SD			
Total	4.54 ± 1.56	4.30 ± 1.40	4.59 ± 1.59
Other children <5 y	1.26 ± 0.49	1.34 ± 0.57	1.25 ± 0.47
Children 6 to <18 y	1.07 ± 1.18	1.10 ± 1.19	1.07 ± 1.18
WIC recipient count, mean ± SD	1.44 ± 0.63	1.55 ± 0.63	1.42 ± 0.62
Redeemed WIC food (%), mean ± SD			
Last 12 mo	53.79 ± 29.29	57.02 ± 28.34	53.12 ± 29.45
Last 6 mo	53.70 ± 30.87	56.89 ± 30.28	53.04 ± 30.96
Last 3 mo	54.78 ± 31.60	57.35 ± 31.36	54.24 ± 31.64

Abbreviations: EN, English-speaking; HS, high school; SD, standard deviation; SNAP, Supplemental Nutrition Assistance Program; SP, Spanish-speaking; WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children.

¹ Poststratification weights were calculated to ensure the survey responses were representative of all WIC-participating households contacted during survey recruitment. Poststratification weights standardized the survey respondents to the statewide WIC population based on county of residence (aggregated to the 10 California regions for the United States Census), race, ethnicity, and language-preference, child age, and WIC benefit redemption pattern classes.

meaningful differences were identified in the sensitivity analysis omitting adjustment for household food insecurity status (Supplemental Table 3).

In models incorporating interaction terms between WIC benefit redemption percentage and child age, significant effect modification was identified for associations between redemption and intake of cheese/tofu and 100% juice (Table 4). Each 25% higher redemption of cheese/tofu, for the 6 and 3 mo before the survey was associated with intakes of 0.05 (95% CI: −0.08, −0.02) and 0.05 (95% CI: −0.08, −0.01) fewer servings/d of cheese among children aged 12 to <24 mo, respectively (*P*-interaction = 0.02 and 0.04, respectively). Each 25% higher redemption of 100% juice, for the 6 and 3 mo before the survey was associated with intakes of 0.12 (95% CI: 0.06, 0.18) and 0.11 (95% CI: 0.05, 0.18) more servings/d of juice among children aged 12 to <24 mo, respectively (*P*-interaction = 0.001 and 0.004, respectively).

Discussion

Category-specific redemption varied widely among WIC-participating households in California from those with high redemption percentages including FV and whole milk to those with low redemption percentages including legumes and yogurt. Associations

were identified between higher redemption of cheese/tofu, breakfast cereal, whole grain bread, yogurt, whole milk, and 100% juice and frequency of child intake for those specific foods.

Redemption of WIC-issued foods from different categories varied widely for both the 6 and 3 mo before the survey. Milk, both whole and reduced fat, were highly redeemed in the 6 mo before the survey (42.32% of families fully redeemed whole milk; 35.80% of families fully redeemed reduced fat milk), which aligns with findings of low partial benefit redemption for milk among WIC participants in Oklahoma [29] and of high milk redemption among participants in Virginia [30]. Food benefits that are highly redeemed include those that are staples of WIC-participating children’s diets, such as milk [17], or are flexible benefits that accommodate household preferences such as the FV benefit [31]. The WIC benefit for FV was highly redeemed (40.62% of families fully redeemed it), which aligns with previous findings from Oklahoma [29], Southern California [32,33], and Virginia [34].

Items with low redemption include yogurt (median 33.3%) and legumes (median 33.3%), which aligns with previous findings of more incomplete redemption of these items by WIC participants in Oklahoma [29]. Previous research in California found that 70% of participating households would prefer greater flexibility in container sizes for WIC-issued yogurt [31], which may contribute to lower redemption of

TABLE 2
Distribution of redemption percentage for 6 and 3 mo before survey completion and dietary intake among respondents to the 2023 Statewide California WIC Survey, March–August 2023 (N, weighted = 2244).

Food benefit category	WIC benefit redemption ¹						Child dietary frequency ²	
	6 mo			3 mo			Food	Servings/d
	n	Zero redeemed (%)	Median (IQR)	n	Zero redeemed (%)	Median (IQR)		
Cheese/tofu ³	2217	6.1	50.0 (20.8, 100.0)	2179	9.5	50.0 (22.9, 100.0)	Cheese	0.66 (0.57)
Eggs ³	2219	3.7	50.0 (25.0, 100.0)	2182	6.1	66.7 (25.0, 100.0)	—	—
Breakfast cereal	2219	8.2	44.0 (20.4, 83.3)	2182	12.5	42.9 (22.2, 100.0)	Cereal	0.70 (0.57)
Legumes	2219	9.3	33.3 (16.7, 83.3)	2182	14.7	33.3 (16.7, 100.0)	Legumes ⁴	0.73 (0.61)
Whole grain bread	2219	10.9	42.9 (20.8, 83.3)	2182	15.1	50.0 (22.5, 100.0)	Whole grain bread	0.54 (0.49)
FV ³	2221	1.8	80.0 (27.2, 100.0)	2183	3.0	75.0 (26.9, 100.0)	FV, ⁵ cups/d	2.76 (0.84)
Yogurt	2217	16.5	33.3 (14.3, 71.4)	2178	22.7	33.3 (11.1, 66.7)	Yogurt	0.62 (0.52)
Whole milk ^{3,6}	823	6.1	75.0 (50.0, 100.0)	639	6.6	66.7 (50.0, 100.0)	Milk	2.02 (1.25)
Reduced fat milk ^{3,6}	1646	7.8	66.7 (33.1, 100.0)	1620	9.7	66.7 (33.3, 100.0)	Milk	2.02 (1.25)
100% juice	2219	6.5	50.0 (25.0, 85.7)	2182	10.2	50.0 (25.0, 100.0)	Juice	1.01 (1.02)

Abbreviations: WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children

¹ WIC benefit redemption is presented as median (25th percentile, 75th percentile), and sample sizes with nonmissing issuance in the specified period are provided.

² Food intake frequency is presented as mean (SD) for servings per day. No food intake frequencies are available for eggs.

³ For these food categories, over 25% of families redeemed all issued food in the 6-mo before the survey. The percentage of families redeeming 100% of issued foods was 25.09%, 28.16%, 40.62%, 42.32%, and 35.80% of families for cheese/tofu, eggs, FV, whole milk, and reduced fat milk, respectively, for the 6-mo before the survey.

⁴ Legume intake frequency was the sum of daily frequency of peanut butter and dried beans.

⁵ Fruit and vegetable intake was determined as cups per day.

⁶ Whole milk is issued to children from 12 mo of age to <24 mo. Children with nonmissing household issuance for whole milk, who were therefore included in subsequent analysis for the association of whole milk redemption with milk intake, were nearly all (>99%) ages 1 or 2 y. Reduced fat milk is issued to children aged ≥24 mo. Children included in analysis for the association of reduced fat milk redemption with milk intake were nearly all (>99%) ages 2–4 y.

yogurt. A 2017 report from the National Academies of Sciences, Engineering, and Medicine on the WIC food packages recommended reducing the amount of legumes issued [27], finding that this item has low redemption and is issued at high levels relative to the recommended intake for children in the Dietary Guidelines for Americans [1]. In April 2024, the USDA released a final rule for revisions of the WIC food packages, required to go into effect by April 2026 [35]. This rule allows state-level WIC agencies both greater flexibility in authorized yogurts of different package sizing and requires states to authorize canned legumes in addition to dried [35]. It will be important to monitor redemption of these items as states implement the new rules.

In the full sample, higher redemption of breakfast cereal, whole grain bread (6 mo only), yogurt, and whole milk were associated higher frequency intake of these items and the likely reason for observed associations vary. The associations between higher redemption of breakfast cereal and whole milk with child intake frequency of these items may be attributable to these items being staples of children’s diets, with households whose children consume more of the specific benefits therefore redeeming more of these benefits. Between 27% and 37% of children aged <2 to 12 y consume ready-to-eat cereal on a given day [36]. Whole milk is the most commonly consumed food or beverage for children at 13- and 24-mo of age [17] and children in low-income households consume more whole milk and less reduced fat milk than children in higher income households [37]. Alternatively for whole grain products and yogurt, which are less prominent in diets of young children, redemption of WIC benefits may increase household availability of these foods and subsequently child intake of these foods. For whole grains, which low-income households are less likely to purchase with non-WIC resources [38] and which are consumed below recommendations for most children ages 2–3 y [39], WIC issuance may contribute to increased purchasing, higher household availability, and more frequent child intake. Similarly for yogurt, which only 33% of children in the United States are estimated to consume at least once a

week [40] and consumption of which declines with lower household income [41], WIC issuance may contribute to increased intake frequency via increased purchasing and household availability of yogurt.

Significant modification of associations between household WIC benefit redemption and child diet by child age was found for cheese/tofu redemption with cheese intake and 100% juice redemption with juice intake. For these 2 foods, a significant association was observed for children aged 12 to <24 mo but not among children age 24–60 mo. Higher cheese/tofu redemption was associated with lower cheese intake frequency, and this inverse association remains unexplained by factors evaluated in this study. Higher 100% juice redemption was associated with higher juice intake frequency among children 12 to <24 mo. Reasons for observed effect modification by child age remain unclear, although changes in child diet with development may be a contributing factor [1]. Recent analyses conducted among WIC participants in Southern California [42] and nationally [43] found higher-than recommended intake of juice both from 12 to <24 mo and at >24 mo of age. Associations between higher juice redemption and intake frequency only among children ages 12 to <24 mo may be attributable to the amount of juice issued by WIC representing a greater proportion of children’s recommended diets at this age [1].

The WIC program aims to increase access to healthy foods necessary for children to thrive by issuing food packages that can be redeemed for set quantities of select age-appropriate healthy foods and beverages and for a set monetary value of FV [14]. WIC benefits reduce the cost of issued foods relative to non-WIC options at the grocery store, which is expected to lead to greater purchase of these items. A randomized trial evaluating decision-making during grocery shopping in a virtual environment found that interventions that increased or decreased the costs of specific foods did have an impact on overall purchasing behaviors, but the effects were generally of small magnitude [44]. Therefore, WIC benefits are thought to increase household-level access to healthy foods and beverages by reducing

TABLE 3
Association between 25 percentage higher in category-specific benefit redemption and dietary intake among respondents to the 2023 Statewide California WIC Survey, March–August 2023 (N, weighted = 2244).

Food benefit category	6 mo		3 mo	
	Estimate (95% CI) ¹	P	Estimate (95% CI) ¹	P
Cheese/tofu	−0.02 (−0.03, 0.00)	0.09	−0.01 (−0.03, 0.01)	0.16
Breakfast cereal	0.02 (0.00, 0.04)	0.02	0.02 (0.01, 0.04)	0.008
Legumes	0.01 (−0.01, 0.03)	0.27	0.01 (−0.01, 0.03)	0.17
Whole grain bread	0.02 (0.00, 0.03)	0.02	0.01 (−0.00, 0.03)	0.06
FV	−0.01 (−0.04, 0.02)	0.36	−0.01 (−0.04, 0.02)	0.53
Yogurt	0.04 (0.02, 0.06)	<0.0001	0.04 (0.02, 0.05)	<0.0001
Whole milk ²	0.09 (0.01, 0.16)	0.02	0.09 (0.00, 0.17)	<0.05
Reduced fat milk ²	0.04 (−0.01, 0.09)	0.11	0.03 (−0.01, 0.08)	0.16
100% juice	0.03 (−0.00, 0.07)	0.08	0.04 (0.01, 0.07)	0.02

Abbreviations: FV, fruits and vegetables; SNAP, Supplemental Nutrition Assistance Program; WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children.

¹ Associations presented are estimated difference (95% CI) in dietary intake associated with each 25 percent higher category-specific benefit redemption. Linear regression models were analyzed for each outcome with terms for independent variables including category-specific benefit redemption and survey method (web or telephone); child age, sex and (combined) race, ethnicity, and language-preference; caregiver education and employment; and household food insecurity, SNAP participation, size, and the number of WIC recipients. All regression models incorporated poststratification weights.

² Whole milk is issued to children from 12 mo to <24 mo of age. Children included in analyses for the association of whole milk redemption with milk intake were nearly all ages 1 or 2 y. Reduced fat milk is issued to children ≥24 mo of age. Children included in analysis for the association of reduced fat milk redemption with milk intake were nearly all ages 2–4 y.

TABLE 4
Association between 25 percentage higher category-specific benefit redemption and dietary intake by child age category among respondents to the 2023 Statewide California WIC Survey, March–August 2023 (N, weighted = 2244).

Food benefit category	6 mo			3 mo		
	Age 12 to <24 mo ¹	Age 24–60 mo ¹	P ²	Age 12 to <24 mo ¹	Age 24 to 60 mo ¹	P ²
Cheese/tofu	−0.05 (−0.09, −0.02)	−0.01 (−0.03, 0.01)	0.02	−0.05 (−0.08, −0.01)	−0.01 (−0.03, 0.01)	0.04
Breakfast cereal	−0.00 (−0.04, 0.03)	0.03 (0.01, 0.05)	0.12	0.00 (−0.03, 0.04)	0.03 (0.01, 0.05)	0.13
Legumes	−0.00 (−0.04, 0.04)	0.02 (−0.01, 0.04)	0.42	−0.00 (−0.04, 0.03)	0.02 (−0.00, 0.04)	0.32
Whole grain bread	−0.01 (−0.04, 0.02)	0.03 (0.01, 0.04)	0.08	−0.01 (−0.04, 0.02)	0.02 (>0.00, 0.04)	0.10
FV	−0.01 (−0.06, 0.04)	−0.02 (−0.05, 0.02)	0.85	−0.00 (−0.05, 0.05)	−0.01 (−0.04, 0.02)	0.76
Yogurt	0.04 (>0.00, 0.07)	0.04 (0.02, 0.06)	0.79	0.04 (0.01, 0.07)	0.04 (0.02, 0.05)	0.87
100% juice	0.12 (0.06, 0.18)	0.00 (−0.04, 0.04)	0.001	0.11 (0.05, 0.18)	0.01 (−0.02, 0.05)	0.004

Abbreviations: FV, fruits and vegetables; SNAP, Supplemental Nutrition Assistance Program; WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children.

¹ Associations presented are estimated difference (95% CI) in dietary intake associated with each 25 percentage higher category-specific benefit redemption in strata of child age. Linear regression models were analyzed for each outcome with terms for independent variables including category-specific benefit redemption and survey method (web or telephone); child age, sex and (combined) race, ethnicity, and language preference; caregiver education and employment; household food insecurity, SNAP participation, size, and the number of WIC recipients; and a 2-way interaction of category-specific benefit redemption and child age stratum. All regression models incorporated poststratification weights.

² P are the type 3 P for the interaction term between child age category and category-specific WIC benefit redemption.

their relative costs [45,46], and given associations between household access and child intake of specific foods [47], it is plausible that greater redemption will lead to greater child intake of WIC-issued foods.

Redemption for some WIC-issued food benefits was not associated with consumption of those foods by participating children. WIC-issued food benefits with null findings included legumes, FV, and reduced fat milk. One possibility is that greater redemption may not lead to increased household availability but, instead, may displace personal expenditures, as was the case in a previous study of the WIC benefit for FV [32,48]. In other words, the WIC benefit may enable families to purchase foods they would already purchase, freeing up those funds to purchase other necessities. FV consumption among WIC-participating children in California is high, since before the FV benefit was increased from 9 United States dollars/mo in May 2021 to a present 26 United

States dollars/mo, which may conceal relationships between redemption and intake at the higher benefit value [32]. Another possibility is that low variability in redemption of foods with low average redemption (legumes) may preclude identification of associations with child diet given the low number of families with high levels of benefit redemption [49].

This study has a number of noteworthy strengths. First among these is the large, randomly selected sample that is representative of WIC-participating households in the state of California and the incorporation of poststratification statistical weights to correct for nonresponse, allowing the study to represent the nearly 15% of WIC participants nationally who reside in California [50]. In addition, WIC benefit redemption for included households were available for the 12 mo before the date of the survey, allowing characterization of long-term

household benefit redemption patterns. Finally, child diet was assessed with the NHANES DSQ, a dietary assessment that has been used successfully in numerous previous studies of child diet and is considered to be valid tool for assessment of the diets of young children in the United States given associations with food intakes assessed with 24-h dietary recalls [22]. The individual food intake frequencies in the NHANES DSQ do not align perfectly with WIC food benefit categories and, therefore, may introduce measurement error to the outcomes of interest for the study (i.e., the frequency of child consumption of WIC foods). The study also was subject to a number of limitations, including the lack of a comprehensive dietary recall for assessing overall diet quality and a single assessment of dietary outcomes, precluding the assessment of associations between temporal patterns in redemption and diet quality. The study was observational, precluding causal inference. Information on household food purchases with other resources (e.g., SNAP and personal funds) was not available and, therefore, cannot be ruled out as a source of residual confounding. Finally, the California WIC participant population is predominantly Hispanic, and generalization to WIC populations in other states should be cautious and informed by differences in participant characteristics.

In conclusion, there was wide variability in the redemption of WIC food benefits among this study population of California WIC-participating households. Some benefits were highly redeemed (FV and whole and reduced fat milk), whereas others were sparingly redeemed (legumes and yogurt). Associations between higher redemption and intake for breakfast cereal, whole grain bread, yogurt, whole milk, and 100% juice demonstrate not only that are WIC-eligible foods important components of the diets of participating children [17], but also that redemption of those foods contributes to the diets of participating children. Further research is necessary to understand how household and participant characteristics contribute to redemption and child diet, to identify associations between redemption and diet quality assessed with 24-h dietary recalls, and to assess whether interventions to improve benefit redemption have a causal impact on child diet quality.

Author contributions

The authors' responsibilities were as follows – CEA: developed the research question; CEA, SEW: designed research; SEW: provided essential materials; CEA: analyzed data; CEA, SEW: wrote the paper; CEA: had primary responsibility for the final content; and both authors: have read and approved the final manuscript.

Conflict of interest

CEA reports financial support was provided by Research Innovation and Development Grants in Economics (RIDGE) Partnership. The other author has no conflicts of interest to disclose.

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Data availability

Data described in the manuscript include confidential administrative data and will not be made publicly available due to a memorandum of

understanding the California Department of Public Health WIC Division.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ajcnut.2024.06.002>.

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