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Trends and Patterns of Chickpea Consumption among United States Adults: Analyses of National Health and Nutrition Examination Survey Data

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A B S T R A C T

Background: Chickpeas are an affordable and nutrient-dense legume, but there is limited United States data on consumption patterns and the relationship between chickpea consumption and dietary intakes.
Objectives: This study examined trends and sociodemographic patterns among chickpea consumers and the relationship between chickpea consumption and dietary intake.
Methods: Adults consuming chickpeas or chickpea-containing foods on 1 or both of the 24-h dietary recalls were categorized as chickpea consumers. Data from NHANES 2003–2018 were used to evaluate trends and sociodemographic patterns in chickpea consumption (n = 35,029). The association between chickpea consumption and dietary intakes was compared to other legume consumers and nonlegume consumers from 2015–2018 (n = 8,342).
Results: The proportion of chickpea consumers increased from 1.9% in 2003–2006 to 4.5% in 2015–2018 (P value for trend < 0.001). This trend was consistent across age group, sex, race/ethnicity, education, and income. In 2015–2018, chickpea consumption was highest among individuals with higher incomes (2.4% among those with incomes <185% of the federal poverty guideline compared with 6.4% with incomes ≥300%), education levels (1.0% for less than high school compared with 10.2% for college graduates), physical activity levels (1.9% for no physical activity compared with 7.7% for ≥430 min of moderate-equivalent physical activity per week), and those with better self-reported health (1.7% fair/poor compared with 6.5% for excellent/very good, P-trend < 0.001 for each). Chickpea consumers had greater intakes of whole grains (1.48 oz/d for chickpea consumers compared with 0.91 for nonlegume consumers) and nuts/seeds (1.47 compared with 0.72 oz/d), less intake of red meat (0.96 compared with 1.55 oz/d), and higher Healthy Eating Index scores (62.1 compared with 51.2) compared with both nonlegume and other legume consumers (P value < 0.05 for each).
Conclusions: Chickpea consumption among United States adults has doubled between 2003 and 2018, yet intake remains low. Chickpea consumers have higher socioeconomic status and better health status, and their overall diets are more consistent with a healthy dietary pattern.

Keywords: chickpeas, hummus, Mediterranean diet, DASH diet, HEI, NHANES

Introduction

The 2020–2025 Dietary Guidelines for Americans (DGA) highlight dietary fiber as a nutrient of public health concern because >90%–97% of United States adults do not meet the recommended intake for this dietary component [1]. This dietary fiber gap is alarming because low intake is associated with increased risks for type 2 diabetes, CVD, and some cancers [2,3]. Cereal crops such as whole wheat and brown rice are correctly promoted as rich sources of dietary fiber, yet pulses (a category of legumes) contain 2–3 times more dietary fiber per 100 kcal serving [4]. Therefore, there is a growing interest in

Abbreviations: DGA, Dietary Guidelines for Americans; FNDDS, Food and Nutrient Database for Dietary Studies; HEI, Healthy Eating Index; IPR, income-to-poverty ratio; SES, socioeconomic status.

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encouraging consumption of pulses to mitigate this dietary fiber gap, as current levels of dietary fiber consumption are very low [4,5].

There are 9 types of legume crops that are commonly consumed globally, including pulses (chickpeas, cowpeas, dry beans, dry peas, and lentils), undried legumes (snap peas and snap beans), and oilseed legumes (peanuts and soybeans) [6]. However, the definition of legumes varies across governing bodies. For example, the USDA definition of legume does not include undried or oilseed legumes [7]. Chickpeas are among the most frequently consumed legumes worldwide, likely due to their low cost and historically high levels of consumption in South Asia, the Middle East, and the Mediterranean region [8,9]. Results from interventional studies of 5–12 wk show that diets enriched with chickpeas improve total and low-density lipoprotein cholesterol concentrations, insulin sensitivity, and lipid peroxidation [10–12]. The favorable effects of chickpea consumption may be attributed to its high contents of dietary fiber (12 g/100 g), protein (21 g/100 g), and total polyphenols (72–181 mg/100 g) as well as low GI [13–15].

The DGA recommend the consumption of 1.5 cups/wk (equivalent to 37.5 g/d) of cooked mature beans, peas, and lentils (including chickpeas) for individuals that require 2,000 kcal/d [1,16]. In addition, consumption of 0.5 cup/d of cooked mature legumes such as dry beans, peas, lentils, and chickpeas (equivalent to 87.5 g/d) is associated with higher diet quality and a lower risk of obesity, CVD, and colorectal cancer [16–19]. Despite these benefits, almost 60% of United States adults consume <0.5 cup/d [16]. A recent analysis of total pulse intake among United States adults suggests that increased consumption of pulses contributes to improved diet quality, and 1 previous publication described chickpea consumption patterns in the United States through 2016, observing an increase in consumption [20,21]. This previous study also demonstrated associations between chickpea consumption and some food groups but did not assess individual nutrients of public health concern or summary measures of dietary quality (for example, the Healthy Eating Index [HEI]). Therefore, the purpose of this investigation using data from a nationally representative dietary survey was to assess *1*) updated trends in chickpea consumption, *2*) chickpea consumption patterns by sociodemographic characteristics, physical activity, body weight, and health, and *3*) the relationship between chickpea consumption and dietary intakes.

Methods

Data sources and population

The NHANES is an ongoing nationwide survey of nutrition and health status conducted by the NCHS at the Centers for Disease Control and Prevention. Data collection protocols include 2 24-h dietary recalls, numerous health and behavioral questionnaires and a medical examination. The collection of dietary data are supported by the USDA and is compiled into a publicly available dataset [22]. Each NHANES biennial cycle of ~9000–10,000 children and adults is representative of the noninstitutionalized United States civilian population [23]. Various populations are oversampled, including Hispanic persons, non-Hispanic Black persons, non-Hispanic Asian persons, lower-income individuals, and younger and older persons. Respondents aged ≥20 y with 2 valid 24-h dietary recalls were included in all analyses. Analyses of trends overall and by sociodemographic characteristics were based on data from 2003–2018 NHANES (n = 35,029) [22]. Analyses of health and health behaviors of chickpea consumers and a comparison of their dietary intakes to other legume consumers (excluding chickpeas) and nonlegume consumers were based on data from 2015–2018 NHANES (n = 8342). Pregnant and lactating women were included in the study to reflect the total population's dietary intakes and patterns. The NCHS obtained approval from its Ethics Review Board, and written informed consent was obtained from all subjects before participating; no additional consent is required for the secondary data analysis of publicly available NHANES data [24].

Dietary assessment methodology

Dietary intake data were obtained from 2 nonconsecutive 24-h dietary recalls [22]. The first 24-h recall was completed in-person at a Mobile Examination Center by a trained interviewer, and the second 24-h dietary recall was completed 3–10 d later via telephone. Respondents reported the types and amounts of all foods and beverages consumed in the preceding 24 h, from midnight to midnight, using a computer-assisted 5-step automated multiple-pass method. The multiple-pass method was conducted by a trained interviewer and probed respondents for foods and beverages consumed, commonly omitted foods, and details about the eating occasion, time of consumption, and amounts consumed using common reference units and examples. Methods are described in more detail on the NCHS website [25,26]. The 24-h dietary recalls were conducted in either Spanish or English, but translation support was available for other languages. Data from both 24-h recalls were used to ensure identification of a sufficient number of chickpea consumers.

Identifying chickpea consumers

Chickpea consumers were identified based on consumption of chickpeas and chickpea-containing foods that were identified in the USDA Food and Nutrient Database for Dietary Studies (FNDDS), the underlying database supporting NHANES used to code foods and beverages consumed. Individual foods that were described or known to contain chickpeas (or garbanzo beans) were identified, including hummus, canned chickpeas, and other items with chickpea(s) in the name or description. Additional foods containing chickpeas or garbanzo beans were identified by querying the FNDDS ingredients table, which disaggregates foods into their component ingredients. Chickpea consumers were defined as NHANES participants who consumed chickpeas on 1 or both 24-h dietary recall days. In NHANES over this study period, the most commonly consumed foods that were identified as containing chickpeas included: plain hummus, vegetable curry, cooked chickpeas, flavored hummus, and lentil curry. Different sources of chickpeas were identified to evaluate trends in chickpea consumption, including hummus and mixed dishes including soup, salads, and others. Further disaggregation (for example, falafel or other preparations) was not possible due to the relative infrequency of chickpea consumption in the United States adult population. In additional analyses, we examined whether the association of chickpea consumption with overall dietary intake of nutrients and dietary patterns differed between chickpea consumers, other legume consumers, and nonlegume consumers (that is, individuals not consuming chickpeas or any other form of legumes). Lastly, sociodemographic characteristics, nutrient intakes, and dietary intake patterns of consumers of hummus and other chickpea forms were analyzed.

Covariates

Analyses describing the relationship between chickpea consumption and sociodemographic characteristics and chickpea consumption and dietary intakes included covariates for age, sex, race/ethnicity, family income-to-poverty ratio (IPR), and education. Age in years was categorized into 3 groups: 20–39 y, 40–64 y, and ≥65 y, and sex was categorized as male and female. Race/ethnicity was defined as: non-Hispanic White, non-Hispanic Black, Mexican-American, other Hispanic, non-Hispanic Asian, and other/mixed race. Family IPR is the ratio of family income to the federal poverty guideline (established as $25,100 in 2018 for a family of 4) accounting for the number of people in the family; cut points included: <1.85, 1.85–2.99, ≥3.00, and a missing indicator. For example, a family of 4 earning $50,000/y would have a family IPR of 2.99 [27]. Education was categorized as: less than high school, high school/high school equivalent/some college, and a college degree or more. Additional covariates to describe chickpea consumers included recreational physical activity, BMI (kg/m^2), self-reported health status, and the number of cardiometabolic conditions present. Recreational physical activity was coded into 4 groups based on minutes of moderate-equivalent intensity physical activity (1 min of vigorous activity = 2 min of moderate activity) in a typical week: none and survey-weighted thirds (10–180, 190–420, and ≥430 min/wk). BMI was calculated based on height and weight measured at the Mobile Examination Center. Underweight individuals were included in all analyses but are not reported as a separate group in the descriptive analysis of BMI categories due to the few respondents with a BMI <18.5 kg/m^2. Presence of cardiometabolic conditions was determined from examination (that is, obesity) and questionnaire data for previous diagnosis of hypertension, high cholesterol, diabetes (excluding prediabetes and gestational diabetes) or prior history of CVD, stroke, or heart failure. Individuals with missing covariate data were not excluded, but the only covariate with missing data was family income; a missing indicator was used in analyses where this was included as a covariate.

Relation to dietary intakes and patterns aligned with DGA

The HEI-2015, DASH Diet Score, and Mediterranean Diet Score were quantified for chickpea consumers, other legume consumers, and nonlegume consumers. The HEI-2015 is an energy-adjusted measure of diet quality that was designed to capture the degree of adherence to the 2015–2020 DGA [1,28]. This measure consists of 9 dietary components that are encouraged, including total fruit, whole fruit, total vegetables, greens and beans, total protein foods, seafood/plant proteins, whole grains, dairy, and a higher ratio of unsaturated to saturated fats. The HEI-2015 also comprises 4 dietary components for which there are recommended limits to consumption, including sodium, added sugars, saturated fats, and refined grains. Consuming plain chickpeas would primarily increase the total vegetables, greens and beans, total protein foods, and seafood/plant protein subscores of HEI-2015, but other foods containing chickpeas would impact other components of the HEI based on their ingredients (for example, fatty acid ratio, sodium, etc). HEI-2015 scores are scaled 0–100, with higher scores are indicative of greater adherence to the DGA. The DASH and Mediterranean Diet Scores measure adherence to the respective dietary patterns and are adapted from prior NHANES publications [29–32].

In addition to analyzing measures of overall diet quality and patterns, intake of selected nutrients and food groups were compared between chickpea, other legume, and nonlegume consumers. The 2015–2020 DGA allow for legumes to count toward vegetable intakes, but we opted to analyze vegetable and legume intake separately. All dietary variables were energy-adjusted per 2000 cal to account for any differences in total dietary energy intake among chickpea consumers and non-consumers. These analyses can be best described as modeling the nutrient or food group density of the diet rather than absolute intakes, consistent with the HEI-2015 approach.

Statistical methods

The analyses were divided into 3 components: *1*) trends in chickpea consumption, *2*) sociodemographic, physical activity, body weight, and health status characteristics of chickpea consumers, and *3*) the relationships between chickpea consumption and dietary intakes and patterns. Consumption trend analyses overall and according to sociodemographic characteristics utilized data from 2003–2018 NHANES; analyses of additional characteristics of chickpea consumers (physical activity, BMI, and health status, including the presence of cardiometabolic conditions) and diet analyses for chickpea, other legume, and nonlegume consumers utilized data from 2015–2018 NHANES, the latest 2 cycles with available data. For the trend analyses, the proportion of chickpea consumers was estimated by combined 4-y cycles, and survey-weighted logistic regression was used to estimate the *P* value for trend. To increase the sample size, 4-y cycles were used instead of 2-y cycles. Additional trend analyses were conducted by source of chickpeas consumed, that is, hummus or other chickpeas, and overall trends were stratified by age, sex, race/ethnicity, family IPR, and education. Time by sociodemographic interactions were also tested. Descriptive analyses of chickpea consumption overall and according to sociodemographic characteristics were conducted using survey-weighted proportions, and heterogeneity by group was assessed using a Wald test for survey-weighted data. The association between chickpea consumption and dietary intakes was assessed using survey-weighted linear regression models with dietary intakes (described above) as the primary dependent variable and chickpea consumption as a dichotomous independent variable. For the relationship between chickpea consumption and dietary intakes, both crude and adjusted models were used. Adjusted models included covariates for age group, sex, race/ethnicity, family IPR, and education (described above in detail). The estimated marginal means for chickpea compared with nonchickpea consumers were calculated, and *P* values for differences are provided. To ensure that results that were not statistically stable were interpreted as such, results where the relative standard error exceeded 30% were flagged as potentially statistically unreliable [33]. NHANES survey weights and design effects were used to ensure that the results are representative of the United States population and variances are properly estimated. All analyses were conducted using Stata 16.1, and an alpha level of 5% was used for all statistical tests.

Results

Trends in chickpea consumption

The proportion of adults consuming chickpeas more than doubled from 2003 through 2018, from 1.9% to 4.5% (*P* value for trend < 0.001) (Table 1). The general trend toward increasing chickpea consumption was observed within all age groups, races/ethnicities, family IPRs, education levels, and both sexes, though these trends were not statistically significant for all subgroups. Furthermore, the trend of increasing chickpea intake over time was consistent for both hummus and other forms of chickpeas (*P* value for trend < 0.001) but was somewhat stronger and more readily apparent for hummus (Figure 1).

Sociodemographic patterns in chickpea consumption

From 2015–2018, 4.5% of adults were identified as chickpea consumers (Table 1). Descriptive analyses demonstrated a greater prevalence of chickpea consumption among those 40–64 y (5.1%) with higher income (6.4%) and education (10.2% for those with a college degree) (Table 1). Chickpea consumption was highest among the non-Hispanic Asian population (12.6%), and lowest among the non-Hispanic Black population (0.7%). Chickpea consumption was higher among individuals with a healthy BMI (6.4%), excellent/very good health (6.5%), no cardiometabolic conditions (6.0%), and greater physical activity levels (7.7%) (Table 2).

Sociodemographic characteristics of different types of chickpea consumers, that is, hummus and other chickpeas, and of other legume consumers compared with chickpea consumers are presented in Supplemental Tables 1 and 2. Consuming legumes (not including chickpeas) was almost 7 times more prevalent than chickpeas, which was driven by individuals identifying as Mexican-American and other Hispanic ethnicities, but was >20% in all race/ethnicity groups. Unlike overall chickpea consumption, consumption of other sources of legumes was relatively consistent across categories of age, income, education, physical activity, and health status. Conversely, consumption of hummus was twice as prevalent as consumption of other sources of chickpeas, and the sociodemographic characteristics of hummus consumers reflected those of overall chickpea consumers (higher income, education level, physical activity level, healthy BMI, better self-reported health status).

Relationship between chickpea consumption and dietary intakes and patterns

Chickpea consumers had lower intakes of sodium (3206 mg/d compared with 3436 mg/d for other legume consumers, *P* < 0.05) and added sugar (11.9 compared with 14.2 tsp/d, *P* < 0.05) and higher intakes of dietary fiber (23.2 compared with 19.9 g/d, *P* < 0.05) and magnesium (350 compared with 316

TABLE 1
Trends in chickpea consumption overall and according to sociodemographic characteristics among United States adults, 2003–2018

A	Chickpea consumers, % (95% CI)				*P*-trend	*P*-interaction
	2003–2006 (*n* = 8182)	2007–2010 (*n* = 9718)	2011–2014 (*n* = 8787)	2015–2018 (*n* = 8342)		
Total	1.9 (1.5, 2.5)	2.7 (2.1, 3.4)	4.1 (3.5, 4.8)	4.5 (3.5, 5.8)	<0.001	—
Age group, y						
20–39	2.8 (2.0, 4.0)	3.0 (2.1, 4.2)	4.2 (3.3, 5.3)	4.8 (3.4, 6.6)	0.02	0.07
40–64	1.6 (1.1, 2.3)	2.6 (1.9, 3.7)	4.3 (3.4, 5.4)	5.1 (3.7, 7.0)	<0.001	
≥65	0.7 (0.4, 1.3)[1]	2.2 (1.5, 3.2)	3.5 (2.3, 5.2)	2.8 (1.9, 4.3)	<0.001	
P-trend	<0.001	0.34	0.54	0.08		
Sex						
Male	1.3 (0.8, 2.1)	2.1 (1.5, 3.1)	3.7 (2.9, 4.6)	4.2 (2.7, 6.3)	<0.001	0.17
Female	2.4 (1.8, 3.3)	3.2 (2.4, 4.2)	4.5 (3.7, 5.6)	4.8 (4.0, 5.8)	<0.001	
P difference	0.03	0.06	0.20	0.46		
Race/ethnicity						
Non-Hispanic White	2.4 (1.7, 3.2)	3.0 (2.3, 4)	4.6 (3.9, 5.6)	4.8 (3.5, 6.4)	<0.001	0.60
Non-Hispanic Black	0.3 (0.2, 0.7)[1]	0.3 (0.2, 0.7)[1]	0.8 (0.4, 1.5)[1]	0.7 (0.4, 1.2)	0.051	
Mexican-American	0.6 (0.3, 1.2)	1.1 (0.6, 1.9)	1.4 (0.6, 3.6)	2.3 (1.3, 3.9)	0.006	
Other Hispanic[2]	-	-	3.3 (2.2, 5.1)	2.4 (1.3, 4.4)	-	
Non-Hispanic Asian[2]	-	-	7.9 (5.9, 10.4)	12.6 (9.2, 14.9)	-	
P difference	<0.001	<0.001	<0.001	<0.001		
Family IPR						
<1.84	1.3 (0.9, 2.1)	1.0 (0.7, 1.4)	1.9 (1.3, 2.7)	2.4 (1.5, 3.6)	0.044	0.50
1.85–2.99	1.7 (1.0, 3.1)	1.7 (1.1, 2.4)	4.3 (2.8, 6.7)	2.8 (1.7, 4.4)	0.053	
≥3.00	2.4 (1.7, 3.3)	4.1 (3.0, 5.6)	5.8 (4.7, 7.1)	6.4 (4.8, 8.5)	<0.001	
P-trend	<0.001	<0.001	<0.001	<0.001		
Education						
<High school (HS)	0.3 (0.2, 0.6)[1]	0.8 (0.4, 1.9)[1]	1.6 (0.8, 3.4)[1]	1.0 (0.5, 1.8)[1]	0.002	0.28
HS/Some college	1.2 (0.7, 2.0)	1.7 (1.3, 2.4)	2.5 (1.9, 3.4)	1.9 (1.5, 2.5)	0.034	
≥College	4.6 (3.4, 6.0)	5.8 (4.5, 7.5)	7.9 (6.4, 9.7)	10.2 (7.8, 13.3)	<0.001	
P-trend	<0.001	<0.001	<0.001	<0.001		

IPR, income-to-poverty ratio.
[1] Interpret with caution due to relative standard error exceeding 30 percent.
[2] Data for these race/ethnicity subgroups is not presented prior to 2011 consistent with NHANES reporting guidelines. These groups were excluded from estimation of the interaction term.

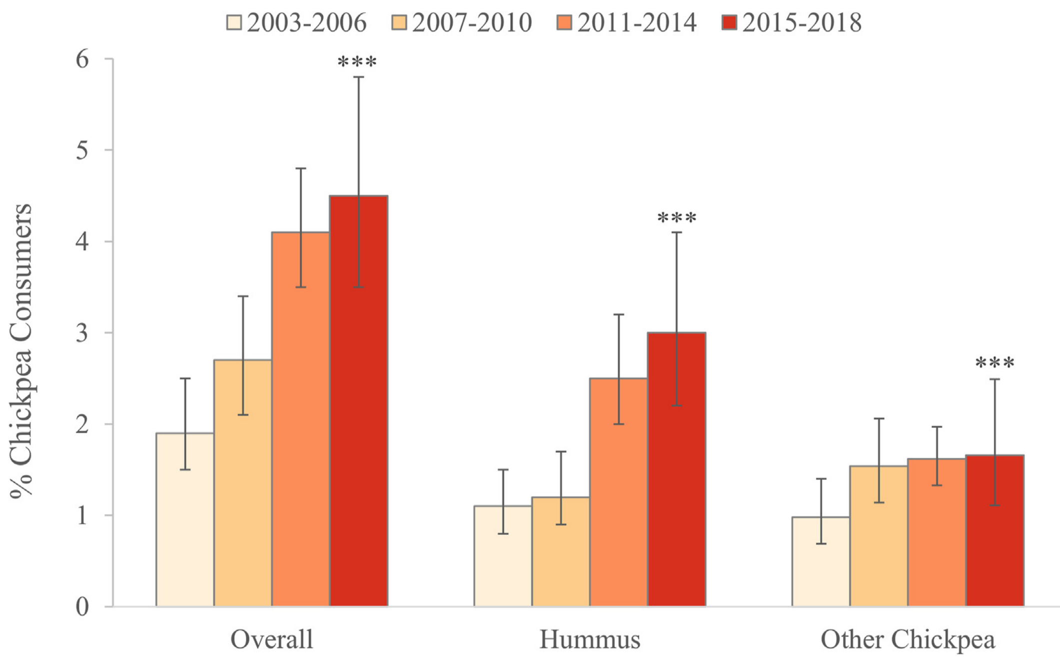

FIGURE 1. Trends in chickpea consumption among United States adults by source. NHANES 2003–2018. Error bars are 95% CIs and asterisks indicate statistical significance comparing consecutive NHANES data cycles; *** $P < 0.001$.

TABLE 2
Physical activity, BMI, and health status, including presence of cardiometabolic conditions, among chickpea consumers, 2015–2018

A	*n*	Chickpea consumers, % (95% CI)
Total	8342	4.5 (3.5, 5.8)
Recreational physical activity, moderate-equivalent min/wk[1]		
None	4329	1.9 (1.3, 2.9)
10–180 min/wk	1587	5.4 (3.7, 7.8)
190–420 min/wk	1132	6.6 (4.6, 9.6)
≥430 min/wk	1280	7.7 (5.3, 11.2)
P-trend		<0.001
BMI, kg/m^2		
Healthy weight: 18.5–24.9[2]	2038	6.4 (4.3, 9.5)
Overweight: 25–29.9	2614	5.1 (3.6, 7.1)
Obese: ≥30	3496	2.9 (1.8, 4.5)
P-trend		<0.001
Self-reported health status		
Excellent/very good	2703	6.5 (4.9, 8.6)
Good	3341	3.7 (2.4, 5.6)
Fair/poor	2005	1.7 (0.8, 3.6)[3]
P-trend		<0.001
Number of cardiometabolic conditions[4]		
None	2361	6.0 (4.2, 8.6)
1	2516	5.0 (3.4, 7.3)
2	1663	3.6 (2.2, 5.9)
≥3	1709	1.7 (0.9, 3.2)[3]
P-trend		<0.001

[1] Moderate-equivalent minutes is calculated from the number of minutes of moderate physical activity and vigorous physical activity, with 1 min of vigorous activity is equal to 2 min of moderate activity.
[2] No underweight category was included due to the small number with BMI <18.5 kg/m^2.
[3] Interpret with caution due to relative standard error exceeding 30 percent.
[4] Cardiometabolic conditions included obesity, and diagnosed/self-reported hypertension, hypercholesterolemia, diabetes (excluding prediabetes and gestational diabetes), CVD, stroke, and heart failure.

mg/d, $P < 0.05$) than other legume consumers, and also nonlegume consumers (Table 3). Regarding food groups, chickpea consumers had greater intakes of whole grains (1.48 oz/d compared with 0.88 oz/d, $P < 0.05$), whole fruit (0.93 compared with 0.88 cups/d, $P < 0.05$), and nuts/seeds (1.47 oz/d compared with 0.77 oz/d, P < 0.05) and lower intakes of red meat (0.96 compared with 1.52 oz/d, $P < 0.05$) compared with other legume consumers and also compared with nonlegume consumers. Dietary patterns were more consistent with the DASH and Mediterranean diets for chickpea consumers compared with both the other legume and nonlegume consumer groups, and for other legume consumers compared with nonlegume consumers. Similarly, the average HEI-2015 score was significantly greater for chickpea consumers (62.1, $P < 0.05$ for both comparisons) compared with other legume consumers (56.5) and nonlegume consumers (51.2) (Table 3 and Figure 2). Supplemental Table 3 reports comparisons of dietary intakes of chickpea consumers compared with nonchickpea consumers in both crude and multivariable-adjusted models, and Supplemental Table 4 describes dietary intakes among hummus consumers, other chickpea consumers, and nonchickpea consumers.

Discussion

The results of this investigation indicate that the proportion of adults consuming chickpeas more than doubled from 2003 to 2018, but the pace of growth slightly slowed in later years. Chickpea consumption is more prevalent among individuals with higher socioeconomic status (SES) and with generally better health status and health behaviors. Furthermore, the diets of chickpea consumers were distinctly healthier, when evaluated using the HEI-2015 and Mediterranean and DASH Diet Scores, than those of individuals who consume other legumes or no legumes. Altogether, it is possible that chickpea consumption

TABLE 3
Comparison of dietary intakes among chickpea consumers, other legume consumers, and nonlegume consumers, 2015–2018

	Multivariable-adjusted[1]		
	Chickpea consumers (n = 309)	Other legume consumers (n = 2626)	Nonlegume consumers (n = 5407)
Kcal/d	2186 (2060, 2313)[a]	2161 (2115, 2208)[a]	2010 (1976, 2044)[b]
Protein, g/d	79.4 (74.2, 84.5)	79.9 (78.4, 81.4)	80.1 (78.9, 81.2)
CHO, g/d	228 (220, 236)[a]	238 (234, 241)[b]	231 (229, 233)[a]
Sugar, g/d	89.7 (83.6, 95.8)[a]	97 (93.5, 100.2)[b]	100.9 (98.9, 102.8)[c]
Added sugar, tsp/d	11.9 (10.4, 13.5)[a]	14.2 (13.4, 15.1)[b]	15.3 (14.7, 15.9)[b]
Fiber, g/d	23.2 (20.8, 25.4)[a]	19.9 (19.4, 20.5)[b]	15.1 (14.7, 15.5)[c]
Total fat, g/d	81.6 (79.3, 83.7)[a]	79.2 (78.2, 80.3)[b]	80.3 (79.4, 81.1)
Saturated fat, g/d	24.4 (22.8, 26.0)[a]	25.8 (25.3, 26.3)	26.2 (25.7, 26.6)[b]
MUFA, g/d	29.4 (27.7, 31.1)[a]	27.5 (27.1, 28.0)[b]	27.7 (27.3, 28.1)[b]
PUFA, g/d	20.2 (18.8, 21.7)[a]	18.4 (18.0, 18.8)[b]	18.8 (18.5, 19.1)
Sodium, mg/d	3206 (3069, 3334)[a]	3436 (3382, 3490)[b]	3364 (3318, 3410)[c]
Calcium, mg/d	989 (874, 1105)	967 (942, 993)[a]	926 (907, 946)[b]
Potassium, mg/d	2678 (2515, 2839)	2692 (2639, 2745)[a]	2551 (2496, 2605)[b]
Vitamin D, μg/d	4.1 (3.1, 5.1)	4.5 (4.1, 4.8)	4.6 (4.4, 4.8)
Iron, mg/d	14.9 (13.9, 15.9)	14.8 (14.4, 15.2)[a]	13.5 (13.3, 13.7)[b]
Magnesium, mg/d	350 (328, 371)[a]	316 (308, 324)[b]	292 (286, 299)[c]
Food groups[2]			
Whole grains, oz/d	1.48 (1.22, 1.73)[a]	0.88 (0.79, 0.97)[b]	0.91 (0.85, 0.97)[b]
Refined grains, oz/d	5.14 (4.54, 5.74)	5.77 (5.48, 6.05)[a]	5.24 (5.10, 5.38)[b]
Legumes, cups/d	0.36 (0.26, 0.45)[a]	0.34 (0.31, 0.36)[a]	0.00[b]
Vegetables, cups/d	1.63 (1.37, 1.91)	1.57 (1.48, 1.66)	1.56 (1.50, 1.62)
Whole fruit, cups/d	0.93 (0.78, 1.09)[a]	0.74 (0.65, 0.83)[b]	0.73 (0.67, 0.79)[b]
Nuts/seeds, oz/d	1.47 (1.09, 1.85)[a]	0.77 (0.66, 0.88)[b]	0.72 (0.63, 0.81)[b]
Dairy, cups/d	1.42 (1.01, 1.83)	1.44 (1.36, 1.52)	1.39 (1.34, 1.44)
Red meat, oz/d	0.96 (0.72, 1.20)[a]	1.52 (1.41, 1.63)[b]	1.55 (1.44, 1.66)[b]
Processed meat, oz/d	0.80 (0.56, 1.05)	0.83 (0.76, 0.90)[a]	0.97 (0.9, 1.03)[b]
Seafood, oz/d	0.47 (0.24, 0.71)	0.57 (0.46, 0.69)	0.67 (0.61, 0.74)
Healthy Eating Index (range, 0–100)	62.1 (59.5, 64.8)[a]	56.5 (55.3, 57.7)[b]	51.2 (50.0, 52.3)[c]
DASH Diet Score (range, 8–40)	26.5 (25.6, 27.5)[a]	23.8 (23.2, 24.4)[b]	22.5 (22, 23)[c]
Mediterranean Diet Score (range, 0–17)	7.5 (6.9, 8.1)[a]	5.9 (5.7, 6.1)[b]	4.9 (4.7, 5.0)[c]

Differing letters indicate that values are different at the $P < 0.05$ level across each row. If there is no letter then the value is not significantly different from any of the other values.

[1] Adjusted for age group, sex, race/ethnicity, family income and education; vegetables exclude legumes.

[2] Conversion factors: The Food Patterns Equivalents Database 2017–2018 provides the gram weights for 1 cup equivalents and 1 ounce equivalents for the USDA Food Patterns components [66].

could be a marker for more favorable health status and dietary intake.

There are several reasons why chickpea consumption may contribute to or be associated with an overall healthy diet. First, chickpeas are a rich source of dietary fiber and protein and are low in nutrients that are commonly overconsumed such as saturated fat, added sugar, and sodium [1,15]. Second, our analysis indicated that chickpea consumers also have higher intakes of whole grains, fruits, and nuts/seeds, illustrating that chickpea intake was not the only driver for overall higher diet quality in the average diet of chickpea consumers. Finally, the higher intakes of whole grains and nuts/seeds among chickpea consumers may be due to complementary food practices. For example, hummus is prepared with both chickpeas and tahini and often consumed alongside whole grain crackers, pita or other savory snacks, resulting in the consumption of whole grains and nuts/seeds in addition to legumes. Conversely, some forms of legumes, namely beans, have historically been prepared by adding fat sources including lard [34].

The average HEI-2015 score was 62.1 for chickpea consumers, which was greater for chickpea consumers than other legume consumers (56.5) and nonlegume consumers (51.2). The higher score for chickpea consumers was the result of slight improvements in some food components that make up the HEI-2015, such as added sugar, whole grains, and the unsaturated to saturated fatty acid ratio. As expected, the greatest differences in HEI-2015 score components were for the seafood/plant proteins and greens and beans categories. Because chickpea consumers have greater overall diet quality, increasing chickpea consumption among the population could conceivably play a role in improving the diet quality and subsequently improving the health of the population. This notion is supported by evidence from randomized controlled trials involving chickpea-containing meals and diets. For example, acute chickpea-containing meals resulted in lower postprandial glucose and/or insulin compared to meals containing white bread or pasta [35–41]. More long-term chickpea-containing diets (4–16 wk) also improved blood lipids and/or glycemic measures in comparison to diets without chickpeas [11,42–47]. Regarding appetite, acute intake of chickpeas did not impact subjective appetite responses [35–38], but daily intake of chickpeas (~104 g/d) for 12 wk resulted in higher satiation when compared to the habitual diet [48]. Altogether, the data from the current analysis indicated that chickpea consumers have greater overall diet quality, and findings from randomized controlled trials suggest that this improvement can contribute to enhanced cardiometabolic health [11,35–38,40–48].

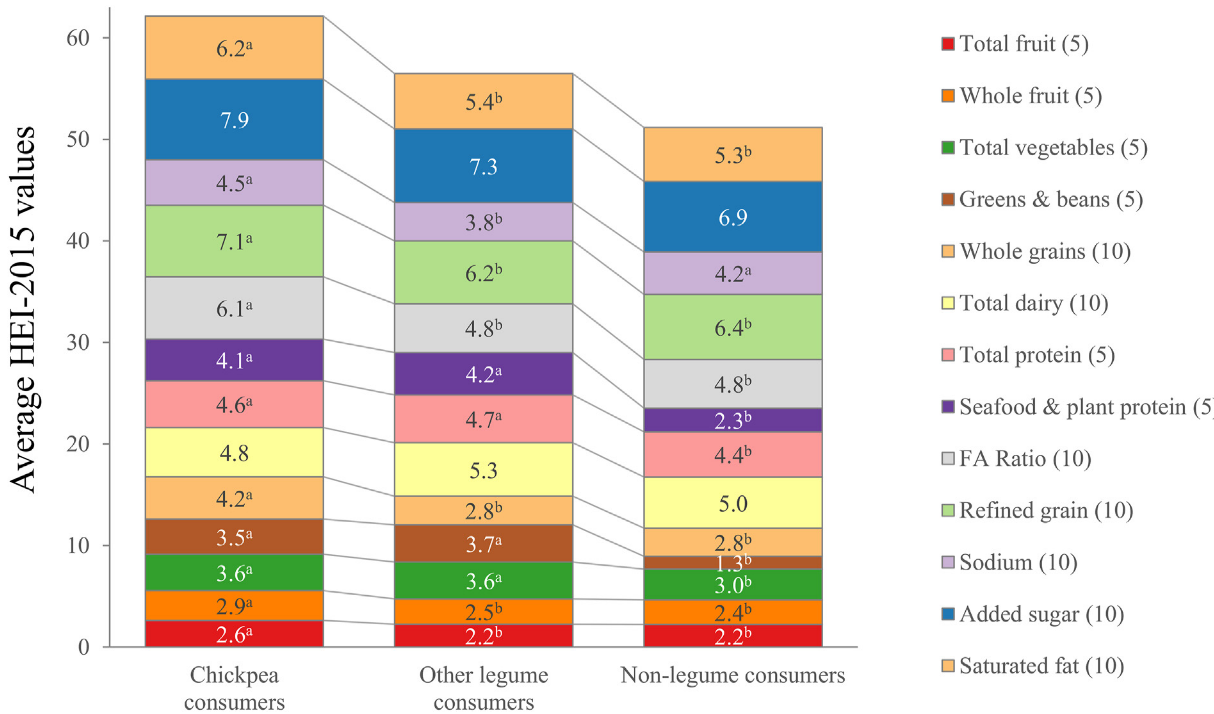

FIGURE 2. HEI-2015 components compared between chickpea consumers, other legume consumers, and nonlegume consumers based on intake data from the NHANES 2015–2018. The HEI-2015 assesses adherence to key recommendations of the Dietary Guidelines for Americans using a scoring system with a score range from 0 to 100, with higher scores indicating greater adherence. A higher intake of saturated fat, added sugar, sodium, and refined grain is indicated by a lower score. A higher intake of all other dietary components is indicated by a higher score. Differing letters within a category indicate that values are different at the 0.05 level. If there is no letter, then the value is not significantly different from any of the other values. Adjusted for age group, sex, race/ethnicity, family income, and education. HEI, healthy eating index.

In addition, the 2020–2025 DGA highlighted the under-consumption of dietary fiber, potassium, calcium, and vitamin D as nutrients of public health concern [1]. A half cup of chickpeas provides >20% of the daily value for dietary fiber [15]. Furthermore, the low cost of chickpeas in comparison to animal sources of protein supports the accessibility of this food to the general population, though it is important to note that chickpeas alone are not a complete source of protein [49–51]. Chickpeas are a staple protein source in many developing and lower/middle-income countries including India, parts of the Caribbean, and some countries in Africa [52], yet our analyses indicated that chickpea consumption is low among United States adults of lower SES, representing somewhat of a paradox. Therefore, increasing chickpea consumption among individuals of lower SES would be required to impact population intake of dietary fiber.

When comparing the results of our analysis to a previous analysis of legume consumption in the United States, there are a few key differences. First, Perera et al. [16] reported that the frequency of legume consumption among United States adults declined from 18.5% in 2011 to 13.7% in 2014, whereas we observed an upward trend of chickpea consumption from 2003 to 2018. This increase in chickpea intake was driven by an increase in hummus consumption but also an increase in consumption from other sources. The growing popularity of Mediterranean-style and plant-based diets may have influenced this trend [53,54]. The Mediterranean diet is generally rich in fruits, vegetables, olive oil, nuts, and legumes and moderate in fish, lean protein, and red wine. Although this diet has been studied since the 1950s, demonstrated reduction in risk of CVD in 2 large randomized controlled trials in recent years has solidified both scientific and consumer interest in this dietary pattern [55,56]. Furthermore, interest in veganism has markedly increased in recent decades. Kamiński et al. [57] reported that veganism was the most frequently searched type of diet by global Google users between 2004 and 2019. The heightened interest in vegan diets was likely due to increased awareness of the benefits of a plant-based diet for human health, animal welfare, and the environment [58]. The Mediterranean-style dietary pattern and the Healthy Vegetarian Dietary Pattern are both recommended by the 2020–2025 DGA [59].

Another key difference between the analysis of legume consumption by Perera et al. [16] and our analysis of chickpea consumption was the sociodemographic profile of consumers, specifically in terms of race/ethnicity. Perera et al. [16] reported that Mexican and other Hispanic populations had the highest proportion of legume consumption. Our analysis confirmed that legume consumption (other than chickpeas) was prevalent among Mexican-American and other Hispanic populations, but chickpea consumption was greatest among the non-Hispanic Asian population. These differences in intake likely reflect cultural norms. Beans are foundational in the typical diet of individuals living in Mexico and Central America [60], whereas chickpeas are commonly used in dishes, such as dal, in India [52,61]. Finally, Perera et al. [16] reported that household income was not associated with legume consumption, whereas our analyses showed that chickpea consumption was over 2.5 times greater for individuals with the highest income compared with the lowest income. It is plausible that this occurred because chickpeas are specifically perceived as healthy in the United

States [62,63], and individuals with higher incomes are more likely to seek out foods that are health promoting or perceived as such [64]. More research needs to be conducted on the health perception of legumes, and chickpeas in particular, and where these perceptions may be similar or different. Furthermore, the increase in chickpea intake was driven in large part by hummus intake, which is generally more expensive than whole dried or canned chickpeas, making hummus more accessible to individuals with higher incomes.

A major strength of this analysis was the use of a large, nationally representative sample. In addition, our analyses considered specific nutrients, food groups, dietary patterns, and overall diet quality to provide a comprehensive view of dietary intake in relation to chickpea consumption. Lastly, our analyses reflect the nutrient density of the diet rather than absolute intakes due to making energy adjustments. A limitation of this study is that the dietary intake data were based on 2 nonconsecutive 24-h dietary recalls; thus, habitual intake may not have been captured, and the chickpea consumption of less frequent consumers may have been missed. Furthermore, self-reported dietary recalls are subject to both systematic and random errors [65]. To mitigate this problem, a multiple-pass method was utilized in which trained interviewers asked follow-up questions to improve the accuracy of the 24-h dietary recalls. Specifically related to estimating chickpea consumption, a very small number of products marketed as hummus do not contain any chickpeas, which could lead to a small overestimation of chickpea exposure. To investigate the prevalence of these products in today's market, a supermarket audit conducted at a large national chain in the Chicago area, supplemented by an internet search, showed that 94 of 103 (91.3% overall) unique stock keeping units (SKUs) across 8 brands of hummus contained chickpeas and that the leading national brands all contained chickpea as the first ingredient. Therefore, the impact of these products on the estimation of chickpea consumption was likely negligible. Another limitation is the cross-sectional nature of NHANES data; thus, causality cannot be inferred particularly with regard to the associations with health status. Finally, the analysis was initiated prior to the availability of the most recent NHANES data, thus more recently developed chickpea products may not have been captured.

In conclusion, chickpea consumption increased from 2003 to 2018 and was most prevalent among individuals of higher SES, greater levels of physical activity, and generally better health status. The diets of chickpea consumers were distinct from other legume consumers as evidenced by greater adherence to healthy eating patterns. The affordability of chickpeas enhances their potential to play a key role in increasing the population intake of dietary fiber, which is a nutrient of public health concern. Future research should investigate the perception of chickpeas and barriers to intake among nonconsumers.

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The authors' responsibilities were as follows—CDR, SG, and JAK: designed the research project; CDR: performed statistical analyses; LLG: wrote the manuscript; MRD, KCM, CDR, and SG: provided project oversight; CDR and KCM: had primary responsibility for the final content; and all authors: read and approved the final manuscript.

Data Availability

All data used in the manuscript are publicly available from the NCHS and USDA. Analytic code is available from the corresponding author on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tjnut.2023.03.029.

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