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Who values gluten-free? Dietary intake, behaviors, and sociodemographic characteristics of young adults who value gluten-free food

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Abstract

Background: Over the past decade, consumer demand for gluten-free products has increased, but little is known about the public health impact and factors correlated with valuing gluten-free food.

Objective: Describe the sociodemographic and behavioral characteristics of young adults valuing gluten-free as an important food attribute, and compare their dietary intake to other young adults.

Design: Cross-sectional analysis of survey data collected in 2015–2016 as part of the fourth wave of the Project EAT (Eating and Activity in Teens and Young Adults) cohort study.

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Author Contributions: MJC conceptualized the study, performed the analysis, and drafted the manuscript. DNS is the study Principal Investigator and was responsible for the conceptualization and implementation of the broader study and contributed to the writing of the manuscript. NL provided oversight for the collection of the survey data used in the analysis described here, contributed to the analysis plan and interpretation of the results, and critically reviewed the manuscript. KH and JM reviewed, edited, and contributed to the proposal, analysis, and manuscript drafts.

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Participants/Setting: Population-based sample of 1,819 young adults (25–36 years) (57% women, 69% white), initially recruited in Minneapolis-St. Paul, Minnesota public middle and senior high schools.

Measures: Valuing gluten-free food, weight goals and weight control behaviors, food production values, eating behaviors, physical activity, and dietary intake.

Statistical Analyses Performed: Logistic regression models were used to investigate associations with potential correlates of valuing gluten-free food. For dietary intake, adjusted mean estimates were calculated for those who did and those who did not value gluten-free foods.

Results: Approximately 13% of young adults valued gluten-free food, a characteristic most strongly related to valuing food production practices (e.g. organic, locally grown); factors such as Nutrition Facts use and having a weight goal were also related to gluten-free food values. Valuing gluten-free food was related to engagement in both healthy behaviors (e.g., eating breakfast daily, eating more fruits and vegetables) and unhealthy behaviors (e.g., using diet pills to control weight).

Conclusions and relevance: Young adults valuing gluten-free food generally engaged in healthier behaviors and had better dietary intake; of concern, they were also more likely to engage in unhealthy weight control behaviors. Valuing gluten-free food may be part of a cluster of behaviors representing an interest in making healthier food choices, but may also be a marker for unhealthy weight preoccupation and behaviors.

Keywords

Gluten; Gluten free; diet; dietary intake; nutrition; young adults

INTRODUCTION

Food labels and claims can influence consumer beliefs concerning food products.^{1, 2} Prior research has shown that certain food labels (e.g. ‘organic’) carry a ‘health halo’ effect, encouraging consumers to opt for such products out of a belief that these products are healthier.^{3, 4} Health halos can be conferred by claims concerning just one nutrient, as consumers often make generalizations about the overall health of a product based on one piece of information found on labels. For instance, products labeled as low sodium⁵, natural⁶, and ‘free from’ certain food components or characteristics⁷ may be interpreted by consumers as being healthier overall. The health halo effect can have unintended consequences on eating habits, such as individuals overconsuming because they feel they have chosen a healthier product.^{8, 9}

‘Free from’ food claims have gained prominence lately in the context of gluten consumption, as gluten-restricted diets have been endorsed by celebrities and cited as facilitating weight loss.^{10, 11} Popular books have claimed that gluten consumption is associated with weight gain¹², anxiety and depression¹³, and that restricting gluten is associated with reduced incidence of autoimmune diseases¹⁴. In 2015, a Gallup poll reported that approximately one in five consumers reported they “actively try to include” gluten-free foods in their diet¹⁵; “gluten-free” was not defined and could have referred to both gluten-

free replacement products (e.g. rice pasta) and foods that are naturally gluten-free (e.g. fruit). Also in 2015, market research publisher Packaged Facts estimated that gluten-free products in traditionally grain-based food categories (i.e. replacement products), accounted for almost \$1.6 billion in sales.¹⁶ Market research has also shown that growth in gluten-free product sales was not driven by individuals with celiac disease¹⁷, for whom a completely gluten-free diet is indicated, but who make up less than 1% of the US adult population¹⁸.

Research has shown that one quarter to one third of consumers believe products containing gluten free claims are healthier than their gluten-containing counterparts^{7, 19}; however, little is known about who values and purchases gluten-free products. Priven *et al.*⁷ found that 'free from' products were rated as healthier more often among those of Hispanic/Latino compared to white ethnicity/race, and for those with an associates or vocational degree compared to those with a doctoral degree. Gallup, in a survey of 1,009 US adults, reported that purchase of specifically gluten-free products was slightly more common among women, non-whites, those without college experience, and those with lower income¹⁵; however, overall demographic characteristics of the survey were not included, and the generalizability is unknown. Further, how valuing gluten-free food relates to weight goals, weight-control behaviors, and health behaviors such as physical activity is an open question. Since popular press reports have suggested eating gluten-free foods or following a gluten-free diet contributes to weight loss^{10–12}, it is crucial to understand how consumers consider gluten-free products in relation to weight control behaviors.

Another key literature gap is in regard to the associations between gluten-free preferences and dietary quality. It is unknown what dietary patterns are exhibited by individuals who value products with gluten in comparison to those who value foods that are naturally gluten free or specialty gluten-free replacement products. Past research comparing nutrients in gluten-containing and gluten-free replacement products suggests gluten-free products may contain more saturated fat and sodium²⁰ and an overall less healthy nutrient profile than gluten-containing counterparts.²¹ However, nutrient profiles differed between brands within each group, and between food categories; for instance, gluten-free breads had higher energy, lower protein, and more total and saturated lipids compared to gluten-containing breads, whereas cereal bars with or without gluten were similar except that gluten-free cereal bars contained less energy.²⁰ Thus, it is possible that consumers purchasing gluten-free foods could unnecessarily be eating poorer-quality food, even while believing it to be healthier; however, it is also possible that incorporating high-quality gluten-free products or naturally gluten-free foods may be in line with an overall healthier dietary profile. Additionally, since health behaviors often co-occur²², it is possible that consumers choosing to incorporate gluten-free foods into their diet for health or nutrition reasons may also be motivated to eat an overall healthier dietary pattern.

This study builds upon prior work to address these literature gaps and inform nutrition counseling and messaging for young adults. The purpose of this study was to describe the sociodemographic characteristics of young adults who valued gluten-free foods and their behavioral profiles in terms of weight goals and weight control behaviors, physical activity and yoga, valuing food production attributes such as organic and locally grown, and food practices including eating breakfast, vegetarian status, and Nutrition Facts use.

METHODS

Study Design and Sample

This cross-sectional study utilized data from the fourth wave of the Eating and Activity in Teens and Young Adults Study (Project EAT-IV), a longitudinal cohort study measuring diet and weight-related factors in adolescents and young adults. Students in 31 public middle- and high-schools in Minneapolis-St. Paul, Minnesota were initially recruited in schools for Project EAT-I in 1998–1999.^{23, 24} Fifteen years later (2015–2016), participants who had responded to at least one of two intermediate follow-up surveys were mailed an invitation for Project EAT-IV. Of the initial school-based sample, 66.1% (N = 1,830) of the N = 2,770 young adults with contact information were surveyed online or by mail, and the 1,819 (99.4%) who answered the question concerning gluten free importance were included in this analysis. All study protocols were approved by the University of Minnesota's Institutional Review Board Human Subjects Committee and all participants provided written informed consent.

Survey Development

Survey items for Project EAT-IV were adapted from the initial Project EAT survey²⁴, and modified based on the social ecological model and a life course perspective.²⁵ Given the growing interest in food attributes such as gluten-free and organic, questions concerning the importance of these attributes were added to the survey, which was pilot-tested with formative focus groups involving a total of 35 young adults. Variables are described below, along with item test-retest reliability for ordinal and continuous variables and percent agreement for categorical variables based on a subgroup of 103 participants who completed the EAT-IV survey twice within a period of one to four weeks.

Variable Definitions

Valuing gluten-free food was the primary variable of interest for this study and was assessed with the question: "How important is it to you that your food is gluten free?", followed by four response options: not at all, a little, somewhat, and very important (test-retest $r=0.67$). Those responding somewhat and very important were categorized as valuing gluten-free food, whereas those responding not at all and a little were categorized as not valuing gluten-free food. Gluten-free value was queried along with values regarding food production practices: organic, not processed, locally grown, and not genetically modified (test-retest ranged from $r = 0.78$ for locally grown to $r = 0.84$ for genetically modified). Interest in food production practices was similarly dichotomized in analyses, as in a previous Project EAT study²⁶.

Height and weight were self-reported in feet and inches and pounds. Self-report measures were highly correlated with objectively measured values in a subsample of the cohort that had their height and weight measured by the research team at the previous wave of follow-up in 2008–2009 ($r = 0.95$ for men, $r = 0.98$ for women)²⁷. Body mass index (BMI) was calculated as kg/m^2 ; BMI < 18.5 was classified as underweight, BMI 18.5–24.9 as normal weight, BMI 25.0–29.9 as overweight status, and BMI ≥ 30 as obese weight status.²⁸

Weight goals were assessed via the question: “Are you currently trying to:” with possible answers of lose weight, stay the same weight, gain weight, and not trying to do anything about weight (test-retest agreement = 84%).

Six healthy weight control behaviors were assessed via the question stem: “How often have you done each of the following things in order to lose weight or keep from gaining weight during the past year?”. Four response options ranging from never to on a regular basis were given, with listed behaviors including exercise, ate more fruits and vegetables, ate less high-fat foods, ate less sweets, drank less soda pop (not including diet pop), and watched my portion sizes (serving sizes). Anyone who reported performing one or more of the six behaviors on a regular basis was considered as performing healthy weight control behaviors (test-retest agreement = 96%), similarly to prior research.²⁹

Nine unhealthy weight control behaviors were assessed using the question stem: “Have you done any of the following things in order to lose weight or keep from gaining weight during the past year?”. The specific behaviors listed after this question included fasted, ate very little food, took diet pills, made myself vomit (throw up), used laxatives, used diuretics (water pills), used food substitute (powder/special drink), skipped meals, and smoked more cigarettes. Response options were yes and no. Test-retest agreement for the combined variable (dichotomous measure of performing any unhealthy behaviors compared to none) was 86%.

Breakfast frequency was assessed via the question: “During the past week, how many days did you eat *breakfast*?”, with five responses ranging from never to every day (test-retest $r = 0.82$). Those who answered every day were categorized as daily breakfast eaters.

Vegetarian status was assessed via the question: “Are you a vegetarian now?”, followed by responses of yes and no (test-retest agreement = 98%).

Nutrition Facts use was assessed using the question “How often do you use the Nutrition Facts panel (or other part of the food label: ingredient list, serving size information) before buying or choosing to eat a food product for the first time?”, with five response options ranging from never to always (test-retest $r = 0.83$). Those responding most of the time and always were categorized as nutrition label users; other responses were considered non-users.

Moderate-to-vigorous physical activity (MVPA) was measured using the Godin Leisure-Time Exercise Questionnaire,³⁰ adapted to include relevant examples and response options ranging from 0 to 6 or more hours per week (test-retest $r = 0.84$). Validation of self-reported MVPA with accelerometer-measured hours of activity was examined in a subsample of the cohort at the previous wave of follow-up.³¹ Those performing 150 minutes or more of moderate-to-vigorous physical activity were considered as meeting physical activity guidelines.³² Yoga practice was assessed by asking if participants had done yoga in the past year, and if affirmative “On average, how frequently did you do yoga over the past year?”, followed by seven responses ranging from: less than ½ hour/week to 10+ hours/week (test-retest agreement = 92% for 30+ minutes/week). For analysis, those who performed 30 minutes per week were compared to those performing <30 minutes/week, and to those who had not performed yoga.

Covariates

Measures of sex, age, ethnicity/race, education, income, and living with children in the past year have been previously described in detail.²⁴ Age was calculated using self-reported birth date and the survey completion date. Education was assessed with the question: “What is the highest level of education that you have completed?” (test-retest agreement = 97%).

Household income was assessed by the question: “What was the total income of your household before taxes in the past year?” (test-retest $r = 0.94$). Living with children was assessed by the question: “During the past year, with whom did you live the majority of the time? (Mark all that apply); those who checked “my child(ren), including any step-children or adopted children” were categorized as living with children (test-retest agreement = 100%). Ethnicity/race was assessed by the question: “Do you think of yourself as White, Black or African American, Hispanic or Latino, Asian-American, Hawaiian or Pacific Islander, or American Indian or Native American?”, with respondents asked to check all that applied. To account for dietary restrictions or health conditions that could impact dietary intake or gluten free preferences, a survey question from EAT-I was included. Participants (surveyed as adolescents from 1998–1999) were asked if they had a physical or health condition that made it difficult to do things other adolescents did, followed by the question: “Does this condition have any effect on the food you can eat?”, with responses of always, sometimes, not at all and I don’t have a health condition. Those reporting always and sometimes were considered as having a health condition that impacted diet.

Dietary Outcomes

Daily servings of fruits, vegetables, whole grains, dairy, and sugar-sweetened beverages (i.e., sodas, sports drinks, punch, lemonade, sugared ice tea) were measured via a semi-quantitative food frequency questionnaire (FFQ).³³ A daily serving was defined as one-half cup for fruits (excluding fruit juice) and vegetables (excluding French fries), 16 g for whole grains, and one cup for dairy. One serving of sugar-sweetened beverages was defined as the equivalent of one glass, bottle, or can.

Fiber (grams), sodium (milligrams), trans fat (grams), dietary glycemic index (a classification system based on blood glucose response where 100 represents glucose^{34, 35}), and saturated fat and added sugars as a percentage of total calories were also estimated from the FFQ. Nutrient intakes were determined using the Nutrition Questionnaire Service Center database at the Harvard School of Public Health³⁶, based on the United States Department of Agriculture’s Nutrient Database for Standard Reference. Reliability and validity of intake estimates have been previously reported.^{37, 38}

Data analysis

Weighted frequencies and chi-squared tests were used to show differences in sociodemographic, behavioral, and weight-related characteristics by gluten-free food value status. The response propensity method³⁹ was used to weight data in all analyses since attrition did not occur completely at random from the school-based sample. Response propensities showing the likelihood of responding to EAT-IV were estimated using a logistic regression of response at follow-up including predictor variables from EAT-I. The weighting allowed for estimates representative of the demographic make-up of the original school-

based adolescent sample surveyed in Minneapolis-St. Paul during 1998–1999, thus being more generalizable to the overall adolescent population in Minneapolis-St. Paul at that time.

To cross-sectionally examine how demographic and behavioral factors (modeled as predictors) were related to valuing gluten-free food, prevalence proportion ratios and confidence intervals were calculated from logistic regression models using the counterfactual method.^{40, 41} Since prior research has shown that sociodemographics may impact food values^{42, 43}, each model adjusted for sex, age, ethnicity/race, education, income, and reporting a health condition that impacted diet. Models involving weight goals and weight control behaviors additionally included weight status as a covariate. A threshold of $p < 0.05$ was set for statistical significance.

To characterize how gluten-free values related to dietary intake, linear regression was used to estimate least squares mean intake, in servings per day, of fruits, vegetables, whole grains, sugar-sweetened beverages, and other indicators of diet quality; all models were adjusted for sex, age, ethnicity/race, income, and education, total caloric intake, reporting a health condition impacting diet, and MVPA.^{24, 44–46} Analyses were performed using SAS v. 9.4 (Cary, NC).⁴⁷

RESULTS

Correlates of Gluten Free Values

The sample included 1,038 women (weighted percent = 49%), and average age was 31.1 ± 1.6 (range: 25–36). Sociodemographic and weight-related characteristics are shown in relation to gluten free values (Table 1). Approximately 13% of young adults valued gluten-free as a somewhat or very important food attribute. Unadjusted chi-square comparisons showed many significant differences in gluten free values by sociodemographic and weight-related characteristics.

In multivariable models (Table 1), Asian and Hispanic participants were more than twice as likely to report valuing gluten-free food compared to white participants. Parents living with children were almost half as likely to value gluten free as young adults without children. Participants who had a BMI ≥ 30 kg/m² were also about half as likely to value gluten-free foods compared to those with a BMI between 18.5–25 kg/m². Participants with specific weight goals (gaining, losing, and maintaining weight) were more likely to value gluten-free food than those without a specific weight goal. Young adults engaged in *only healthy* weight control behaviors were 2.4 times more likely to value gluten-free food compared to participants who did not engage in any weight control behaviors. However, those engaged in *only unhealthy* weight control behaviors or *both healthy and unhealthy* weight control behaviors were 3.1 and 3.2 times more likely to value gluten-free food compared to the comparison group of individuals not engaging in any weight control behaviors.

Table 2 shows how valuing gluten-free food related to valuing food production practices, and engaging in dietary and eating habits, and physical activity. Participants who valued food production practices (organic, not processed, locally grown, not genetically modified) were far more likely (4–7 times) to value gluten-free food. Daily breakfast consumption,

Nutrition Facts use, meeting physical activity guidelines, and regular yoga practice were all associated with valuing gluten-free food as an important food attribute.

Dietary Comparisons

Participants who valued gluten-free food exhibited markers of a healthier overall dietary pattern. Those valuing gluten-free food consumed approximately 1 more daily serving each of fruit and vegetables and 20% more fiber compared to those who did not value gluten free (Table 3). Valuing gluten-free food was also related to consuming fewer sugar-sweetened beverages, less sodium and trans fat, lower proportions of daily energy intake from saturated fats and added sugar, and lower dietary glycemic index (all $p < 0.05$). Whole grain intake did not differ according to valuing gluten-free as an important food attribute. Dairy intake was slightly lower for those who valued gluten-free food ($p < 0.05$).

DISCUSSION

This study was one of the first large population-based studies to investigate characteristics of young adults who value gluten-free food and the relation between gluten-free food values and diet quality. Approximately 13% of young adults valued gluten-free as an important food attribute. Valuing gluten-free products was strongly related to valuing food production practices, including organic, not processed, locally grown, and not genetically modified. Those who valued gluten-free food showed markers of a healthier dietary profile and were more likely to perform healthy behaviors such as eating breakfast daily and meeting physical activity guidelines. However, of concern, those who valued gluten-free food were also more likely to perform at least one of nine unhealthy weight control behaviors, such as using diet pills and/or vomiting to control weight.

This study builds upon prior research describing the sociodemographic profile of consumers who value various food attributes. In Project EAT-IV, valuing gluten-free food was higher for Asian and Hispanic; however, age, sex, education, and income were not related to gluten-free values in adjusted models. Taken in the context of prior research^{7, 15}, there seems to be some consistency in individuals of non-white ethnicity/race in the US valuing 'free-from' foods. Since ethnic/racial minority sub-groups may receive targeted food marketing⁴⁸, future research may consider the impact of marketing on gluten free and other food values.

Young adults with a lower weight status, specific weight goals, and those who engaged in healthy weight control behaviors were all more likely to value gluten-free foods. However, valuing gluten-free food was three times higher for young adults engaging in unhealthy weight control behaviors compared to those who did not engage in any weight control behaviors. Taken together, these results could suggest that young adults may see 'gluten-free' foods as healthier, or as promoting weight loss, and that individuals may believe claims concerning gluten consumption and weight¹². This aligns with prior 'health halo' research indicating that consumers believe gluten-free products are healthier than gluten-containing foods¹⁹, and extends the literature by relating gluten-free values to weight goals and weight control behaviors. Unnecessarily following a restrictive diet such as gluten-free may be associated with a fixation on healthy eating⁴⁹, and future research should investigate how restrictive dieting may relate to unhealthy weight control behaviors among young adults.

Clinicians advising young adult clients following a gluten-free diet may consider asking clients about their weight control behaviors to explore whether they are using gluten-free diets or products in an unhealthy way to restrict intake. It is also important for future research to account for health concerns and reasons behind weight goals. Of note, valuing gluten free food was proportionally higher for the small group of 60 young adults who expressed the goal of gaining weight (12 out of the 60 valued gluten-free food), even accounting for weight status at EAT-IV and health conditions impacting diet at EAT-I. These results could have been driven by the small sample size or a variety of motivations or possible health conditions; post-hoc analyses showed that the majority of participants who wanted to gain weight were men ($n = 38$) and had a healthy BMI between 18.5–24.9 kg/m² ($n = 42$).

Valuing gluten-free foods was most strongly related to valuing food production practices such as organic, which consumers often interpret as healthier than conventional foods without food production claims.^{3, 4} In Project EAT-IV, those who valued gluten-free food were also more likely to engage in healthy behaviors such as eating breakfast daily, and meeting physical activity guidelines. This finding parallels prior studies showing that behaviors that are actually, or perceived to be, health-promoting behaviors may co-occur²² and further supports research suggesting that ‘gluten-free’ may carry a health halo where consumers believe it reflects overall healthiness^{7, 19}. Of note though, the relationship shown between various food values in Project EAT studies could also partially be due to the fact that questions concerning food values were asked together in the same section of the survey. Future research should consider the broad range of possible motivations for valuing gluten-free products, and health behaviors that may co-occur with consuming gluten-free foods. Besides weight goals, consumers may be interested in other perceived health impacts of eating gluten-free; Dunn *et al.*¹⁹ reported that a fifth of consumers surveyed believed a gluten-free diet could improve skin/complexion, and over a third believed it would improve digestive health. It is also critical to understand how consumers internalize nutrition messages, both those with and without a scientific basis.

In addition to the observed associations with healthy eating behaviors, those valuing gluten-free food exhibited a healthier dietary pattern compared to those who did not, including consuming more fruits, vegetables and fiber, less sodium, fewer sugar-sweetened beverages, and a smaller proportion of energy from saturated fat. Those who valued gluten-free food had a daily dietary pattern more in line with MyPlate⁵⁰ and did not appear to have negative dietary consequences other than slightly lower dairy intake, but on average still failed to meet recommendations for intake of dairy, vegetables, and fruit. Notably, whole grain intake, which was relatively low among all participants, did not differ by gluten-free values in this study. This is somewhat contrary to prior research finding that whole grain intake may be lower among those eating low or no gluten^{51, 52}, and that gluten-free products are often deficient in necessary nutrients⁵³ or higher in calories⁵⁴, saturated fat and salt²¹. However, Project EAT-IV measured perceived *value of gluten-free foods* rather than *consumption*. Additionally, it is unknown whether participants who valued gluten-free food were expressing a value of gluten-free specialty products designed to replace gluten-containing products, versus naturally gluten-free foods. These gaps in understanding reasoning for gluten-free values and how gluten free values might impact gluten consumption should be

further studied, with a particular focus on groups that may be at especially high risk of nutritional deficiencies such as pregnant and breastfeeding women.

Irrespective of dietary quality, gluten-free products are often far more expensive than gluten-containing counterparts.^{55–57} Gluten-free products also have more limited availability,^{55, 57} thereby imposing time costs on those seeking these products. These may be particularly costly for families and individuals with lower income. Thus, while valuing gluten-free foods is not necessarily harmful and was even cross-sectionally related to healthier dietary patterns in Project EAT, dietitians and health professionals should consider costs such as time and money when advising patients and clients.

Strengths and Limitations

This study possessed many strengths: of note, it is one of the first population-based studies to describe sociodemographic and behavioral characteristics of individuals who value gluten-free food. This is particularly important because prior studies have often occurred in market research samples that were not well described¹⁵ and in small exploratory samples.¹⁹ Second, gluten-free value was assessed using a survey that measured a broad range of individual characteristics and allowed for holistically describing individuals who value gluten-free foods. Third, several different dietary outcomes were assessed in the study, including whole grains, which have been noted as a concern for those eating low gluten diets.⁵¹ Last, this study involved a large, population representative sample of young adults.

Several limitations were also present in this study. First, participants were not asked about the reason(s) underlying their gluten-free rating or gastrointestinal symptoms in relation to gluten consumption, so it is impossible to infer health-related reasons for valuing or not valuing gluten-free foods in this study. However, by controlling for having a health condition impacting diet (surveyed at adolescence) and given the low prevalence of celiac disease,¹⁸ it is unlikely that gluten intolerance greatly biased the results of this study. Since the prevalence of individuals consuming a gluten-free diet in the US is estimated to be less than 2% based on nationally-representative data^{18, 58} and yet 20% of consumers try to include gluten-free foods in their diet¹⁵, it is very likely many US adults, including the 13% of Project EAT-IV participants who valued gluten-free food, may value and/or incorporate gluten-free food products into their diet while not necessarily following a gluten-free diet. Second, given these data are cross-sectional, it was impossible to examine longitudinal dietary intake or risk for health outcomes, such as weight gain. Third, this study only observed gluten-free values; intake of gluten, gluten-free replacement products, and naturally gluten-free food was not assessed by the food frequency questionnaire. Future studies should particularly assess intake of gluten-free replacement products since these products may exhibit different nutritional profiles from naturally gluten-free foods. Also, all variables in this study were self-reported, including diet, height and weight, and behavioral characteristics, each of which are vulnerable to social desirability bias by the respondents. This could have biased estimates for dietary quality away from the null, i.e. participants subject to bias and perhaps those rating gluten-free as important could have had less healthy diets than they reported. Last, although this sample was large and diverse, participants were originally recruited from one geographic area and loss-to-follow-up did not occur

completely at random, thus leaving the possibility for selection bias; response weights were therefore used in analyses to enhance the generalizability.

Conclusions

The results of this study suggest that 'gluten free' may confer a health halo and cluster with other health-motivated behaviors (perceived or actual). Young adults who valued gluten-free foods were likely to value food production practices including organic, not processed, locally grown, and not genetically modified, and were more likely to perform healthy behaviors such as eating breakfast daily and meeting physical activity recommendations. However, valuing gluten-free food was also related to unhealthy weight control behaviors, which is of concern. Young adults valuing gluten free-foods were more likely to exhibit markers of higher diet quality (more in line with the Dietary Guidelines for Americans), although dietary intake still did not meet most of the guidelines. Future research is needed to characterize motivation for consuming gluten-free products, in addition to elucidating the relation between intake of gluten-free products and health outcomes among general healthy populations. Young adults should be advised that eating gluten-free products may not improve weight or health outcomes; associations with positive eating behaviors and dietary intake among the population-based EAT cohort are most likely due to a clustering effect involving the adaptation of behaviors perceived as potentially helpful.

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RESEARCH SNAPSHOT**Research Question:**

Who values gluten-free as an important food attribute, and how does valuing gluten-free food relate to dietary intake?

Key Findings:

In a cross-sectional population-based survey of 1,819 young adults, valuing gluten-free food as important was related to markers of a healthier dietary pattern, valuing food production practices such as organic or locally grown, and practicing several healthy behaviors such as eating breakfast daily and meeting physical activity guidelines. Of concern, valuing gluten-free food was also related to engaging in unhealthy weight control behaviors.

PRACTICE IMPLICATIONS

What Is the Current Knowledge on this Topic?

Sales of gluten-free products have increased worldwide in the past decade. Studies have suggested that gluten-free products have a ‘health halo’ effect, and that consumers believe them to be healthier than products containing gluten.

How Does this Research Add to Knowledge on this Topic?

This is one of the first population-based studies to describe sociodemographic and behavioral characteristics of young adults who value gluten-free food, and compare dietary intake for those who did and did not value gluten-free food.

How Might this Knowledge Influence Current Dietetics Practice?

Nutrition professionals counseling gluten-free clientele should probe for reasons underlying valuing gluten-free food and/or adherence to eating gluten free along with other behaviors, particularly weight control, to promote overall nutrition and health.

Table 1.

Unadjusted percent and adjusted prevalence proportion ratios showing sociodemographic and weight-related factors in relation to valuing gluten free food in young adults ($N = 1819$) in Project EAT-IV.^a

Characteristics	N	Value Gluten Free % ^b	Prevalence Proportion Ratio [CI] ^c
Total population	1819	13.0	
Sociodemographic Factors			
Sex			
Men	785	12.7	1.0 [ref]
Women	1038	13.4	1.07 [0.83, 1.41]
Age (mean: 31.1)			
25–30 years old	573	12.5	1.0 [ref]
31–36 years old	1246	13.2	1.12 [0.84, 1.51]
Ethnicity or race			
White	1240	8.5 *	1.0 [ref]
Black	153	13.0	0.88 [0.55, 1.37]
Asian	264	22.7 *	2.54 [1.88, 3.41] *
Hispanic	62	22.1 *	2.15 [1.39, 3.21] *
Other race	90	12.3	1.57 [0.98, 2.45]
Annual Income			
Low (\$0-\$49,999)	650	15.4 *	1.0 [ref]
Middle (\$50,000-\$99,999)	707	11.5	0.83 [0.61, 1.12]
High (\$100,000+)	435	8.6 *	0.70 [0.45, 1.06]
Education			
High school graduate or less	413	16.6 *	1.0 [ref]
Associate/technical degree	444	10.9	0.80 [0.56, 1.13]
Bachelor degree or higher	956	10.6 *	0.89 [0.64, 1.24]
Parental Status			
Non-parent	1091	15.7	1.0 [ref]
Parent	723	8.5 *	0.53 [0.39, 0.71] *
Weight-related Factors			
Weight Status Assessed via BMI ^d			
Underweight (<18.5 kg/m ²)	22	17.7	1.33 [0.47, 3.20]
Normal weight (18.5 BMI < 25 kg/m ²)	712	15.7 *	1.0 [ref]
Overweight (25–29.9 kg/m ²)	585	14.2	0.81 [0.59, 1.10]
Obesity (≥ 30 kg/m ²)	483	8.3 *	0.48 [0.33, 0.69] *
Weight Goals ^c			
Nothing in particular	422	9.6 *	1.0 [ref]

Characteristics	N	Value Gluten Free % ^b	Prevalence Proportion Ratio [CI] ^c
<i>Gain weight</i>	60	27.9 [*]	2.32 [1.34, 3.70] [*]
<i>Stay the same weight</i>	362	13.3	1.65 [1.09, 2.43] [*]
<i>Lose weight</i>	975	13.0	2.06 [1.41, 2.99] [*]
Weight Control Behaviors ^e			
<i>None</i>	378	5.9 [*]	1.0 [ref]
<i>Only Healthy Behaviors</i>	563	11.7	2.43 [1.63, 3.57] [*]
<i>Only Unhealthy Behaviors</i>	208	15.9	3.07 [2.00, 4.48] [*]
<i>Both Healthy and Unhealthy</i>	652	17.6 [*]	3.18 [2.14, 4.64] [*]

^aProject EAT-IV, the fourth wave of the Eating and Activity in Teens and Young Adults Study.

^bPercentages are shown for each group (eg, percent of women who value gluten-free), and weighted to account for selection bias. Among variables with more than two groups (eg, education), comparisons tested differences between each category (eg low education) and all other categories (eg, middle and high education).

^cPrevalence proportion ratios show valuing gluten-free (modeled as the outcome variable); each model adjusted for sex, age, ethnicity/race, education, income, and having a health condition impacting diet. Ref =reference category.

^dBMI, body mass index; calculated as kg/m².

^eAdditionally adjusted for weight status.

^{*}P<0.05.

Table 2.

Unadjusted percent and adjusted prevalence proportion ratios showing how gluten-free values related to food production values, dietary and eating behaviors, and physical activity in young adults ($N = 1819$) in Project EAT-IV.^a

Food Production Values	N	Value Gluten Free %	Prevalence Proportion Ratio [CI] ^b
Organic			
<i>Does not value organic</i>	1120	5.7	1.0 [ref]
<i>Values organic</i>	703	24.5 *	4.08 [3.02, 5.50] *
Food Processing			
<i>Does not value non-processed food</i>	818	4.5	1.0 [ref]
<i>Values non-processed food</i>	1004	20.5 *	5.74 [3.90, 8.46] *
Local			
<i>Does not value local food</i>	1033	5.4	1.0 [ref]
<i>Values locally-grown food</i>	782	23.1 *	4.16 [3.03, 5.73] *
Genetically Modified (GMO)			
<i>Does not value non-GMO food</i>	958	4.0	1.0 [ref]
<i>Values non-GMO food</i>	863	22.6 *	7.11 [4.75, 10.64] *
Dietary and Eating Behaviors			
Breakfast Frequency			
<i>Does not eat breakfast daily</i>	1056	11.1	1.0 [ref]
<i>Eats breakfast daily</i>	766	16.3 *	1.79 [1.37, 2.35] *
Vegetarian			
<i>Non-vegetarian</i>	1751	12.9	1.0 [ref]
<i>Vegetarian</i>	71	15.1	1.58 [0.81, 2.84]
Nutrition Facts Use			
<i>Does not use Nutrition Facts</i>	1164	10.8	1.0 [ref]
<i>Uses Nutrition Facts</i>	646	16.6 *	2.22 [1.69, 2.92] *
Health condition impacting diet			
<i>None</i>	1673	11.6	1.0 [ref]
<i>Has health condition</i>	90	19.2 *	1.21 [0.76, 1.88]
Physical Activity			
Physical Activity Guideline Adherence ^c			
<i>Not meeting guidelines (<2.5 hrs/wk)</i>	649	11.0	1.0 [ref]
<i>Meeting guidelines (≥ 2.5 hrs/wk)</i>	1174	14.1	1.51 [1.13, 2.03] *
Yoga Practice			
<i>Practices yoga < 30min/wk</i>	1514	11.6	1.0 [ref]
<i>Practices yoga ≥ 30min/wk</i>	299	20.0 *	1.78 [1.27, 2.47] *

^aProject EAT-IV, the fourth wave of the Eating and Activity in Teens and Young Adults Study.

^b Prevalence proportion ratios show valuing gluten free (modeled as the outcome variable); each model adjusted for sex, age, ethnicity/race, education, income, and having a health condition impacting diet.

^c 2.5 hours of moderate-to-vigorous physical activity (MVPA) per week was considered meeting the Physical Activity Guidelines for Americans.

^{*} (p<0.05).

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Table 3.

Dietary intake (mean servings/day $\pm$ SE)^a by gluten free values in young adults ($N = 1529$) in Project EAT-IV.^{b,c}

Dietary Intake	Gluten Free Values		p value
	Important	Not Important	
Fruit, excluding fruit juice (1/2 c. servings)	2.4 $\pm$ 0.1	1.5 $\pm$ 0.0	<0.001
Vegetables, excluding potatoes (1/2 c. servings)	3.6 $\pm$ 0.2	2.7 $\pm$ 0.1	<0.001
Dairy (1 c. servings)	1.4 $\pm$ 0.1	1.6 $\pm$ 0.0	0.033
Whole grains (16-g servings)	2.2 $\pm$ 0.1	2.1 $\pm$ 0.0	0.788
Sugar-sweetened beverages (servings) ^d	0.3 $\pm$ 0.1	0.6 $\pm$ 0.0	<0.001
Fiber (gm)	26.1 $\pm$ 0.6	21.0 $\pm$ 0.2	<0.001
Saturated fat, % of total calories	10.3 $\pm$ 0.2	11.0 $\pm$ 0.1	<0.001
Trans fat (gm)	1.2 $\pm$ 0.0	1.4 $\pm$ 0.0	<0.001
Sodium (mg)	1864 $\pm$ 38	2053 $\pm$ 14	<0.001
Added sugars, % of total calories	9.1 $\pm$ 0.5	11.1 $\pm$ 0.2	<0.001
Dietary Glycemic Index	52.0 $\pm$ 0.3	53.3 $\pm$ 0.1	<0.001

^aSE = standard error.

^bProject EAT-IV, the fourth wave of the Eating and Activity in Teens and Young Adults Study.

^cLeast squares means adjusted for sex, ethnicity/race, education, income, weekly hours of moderate-to-vigorous physical activity, having a health condition impacting dietary intake, and total caloric intake.

^d $N=1528$