# Self-reported use of nutrition labels to make food choices is associated with healthier dietary behaviours in adolescents

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## Abstract

*Objective:* The study aimed to examine nutrition label use and dietary behaviours among ethnically diverse middle- and high-school students, in Texas, USA.
*Design:* The School Physical Activity and Nutrition (SPAN) survey is a cross-sectional statewide study using a self-administered questionnaire to assess nutrition and physical activity behaviours. Height and weight measurements were used to determine BMI. Multivariable logistic regression was used to determine associations between nutrition label use and dietary behaviours, with gender, grade, ethnicity, BMI, parent education, socio-economic status and nutrition knowledge as covariates.
*Setting:* Participants from 283 schools, weighted to represent Texas youth.
*Subjects:* SPAN 2009–2011 included 6716 8th and 11th graders (3465 girls and 3251 boys). The study population consisted of 39·83 % White/Other, 14·61 % African-American and 45·56 % Hispanic adolescents; with a mean age of 14·9 years, and 61·95 % at a healthy weight, 15·71 % having overweight and 22·34 % having obesity.
*Results:* Adolescents who did not use nutrition labels had 1·69 times greater odds of consuming ≥1 sugary beverages/d ($P < 0.05$). Adolescents who used nutrition labels had 2·13 times greater odds of consuming ≥1 fruits and vegetables/d ($P < 0.05$). Adolescents who used nutrition labels had significantly higher healthy eating scores than those who did not ($P < 0.001$). For every 1-point increase in nutrition knowledge, adolescents had 1·22 greater odds of using nutrition labels.
*Conclusions:* Nutrition label use is associated with healthier dietary behaviours in adolescents. Intervention strategies for youth should include efforts to teach adolescents to use labels to make healthy food choices.

In 1990, the US Nutritional Labeling and Education Act was passed, requiring the use of a standardized nutrition label. Nutrition labels are required on almost all packaged foods and processed meat products[1]. An estimated 96·3 % of processed, packaged foods regulated by the Food and Drug Administration have Nutrition Facts labels[2]. The Nutrition Facts labels contain information regarding serving size, energy (calories), Percent Daily Value, nutrients to increase (calcium, dietary fibre, vitamin A, vitamin C, protein) and nutrients to decrease (total fat, cholesterol, sodium). Nutrition labels are important for helping the public understand the nutritional composition of a product so that they can make informed decisions on the foods to consume to achieve a healthy diet.

Since nutrition labels were introduced in 1993, Americans' diets have changed, but these changes have not been towards heathier eating patterns[3]. Americans continue to eat larger serving sizes despite the fact that obesity, heart disease and stroke rates remain high[4]. Because of this, on 20 May 2016, the Food and Drug Administration introduced changes to the Nutrition Facts label to reflect new scientific information, including the link between diet and chronic diseases such as obesity and heart disease[5]. The major changes include the addition of 'added sugars' in grams with the Percent Daily Value, and the changing of serving size to indicate how much people are eating instead of how much they should eat. For example, both a 12-ounce (354 ml) and a 20-ounce (591 ml) bottle will indicate one serving per bottle and the nutrition labels will reflect the individual bottle size. Vitamin D and potassium will be required on the label, and vitamins A and C will no longer be required but can be included on a voluntary basis. This is because Americans' current diets are deficient in vitamin D and potassium, and vitamins A and C are not a current public health problem[5].

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Current research on adult nutrition label use shows significant associations between nutrition label use and healthier diets[6]. Adults who used nutrition labels consumed 6% less dietary fat than adults who did not use nutrition labels, and this difference accounted for a significant decrease in risk for diet-related chronic diseases[7]. Adults with higher household incomes and higher education levels were more likely to use nutrition labels[8]. Of adults, men who read nutrition labels had higher intakes of calcium and vitamin C, and women who read nutrition labels consumed less energy and carbohydrates than women who did not[8]. Many studies have examined adult use of nutrition labels and behavioural patterns associated with it, but very few studies have examined adolescent use of nutrition labels.

Parents are the gatekeepers to their children's diets, but students in the 8th and 11th grade begin to feel a greater sense of autonomy as they increase their decision-making abilities, such as making their own food choices[9,10]. Adolescents can influence foods that parents buy and often have the opportunity to choose between different foods, especially with regard to snack foods[11]. In particular, most US 11th grade students can drive, and this increased mobility and independence allows them to eat or select foods without parental oversight. Therefore, adolescents are a particularly relevant group to study. Over the past 30 years, childhood obesity has more than quadrupled in adolescents, with 20·5% of adolescents aged 12–19 years being classified as obese[12,13]. Few studies have examined how nutrition label use is associated with the dietary behaviours of adolescents and children. One study found that reading nutrition labels was significantly associated with percentage energy intake from fat among adolescents[14]. Specifically, percentage energy intake in girls did not change with nutrition label use, but boys who read nutrition labels consumed more energy from fat[14]. That study also showed that nutrition label use did not correlate with healthier diets in adolescents. Another study showed that nutrition label use was common among adolescents, but they appeared to be concerned only with information relating to the expiration date and not the nutritional information[15]. Yet another study, based on data from the National Nutrition Health and Examination Survey (NHANES), indicated that use of nutrition labels is low among adolescents[16]. These studies indicate that nutrition labels do not seem to be utilized to obtain nutritional information as intended; one reason for this may be a lack of nutrition knowledge among adolescents, and that nutrition education may be needed to help children and adolescents better understand nutrition labels. However, none of these studies examined associations between nutrition label use and dietary behaviours by adolescent age or race/ethnicity, and only one of these studies examined differences in nutrition label use by gender.

Knowledge of the associations between nutrition label use and dietary intake, and how these associations differ by grade, gender and race/ethnicity, is needed to tailor strategies that will help adolescents make informed dietary decisions. The objective of the present study was to examine nutrition label use and dietary intake among ethnically diverse middle-school and high-school students in Texas, USA, using the School Physical Activity and Nutrition (SPAN) population-based surveillance data from 2009–2011.

## Methods

### Study design

SPAN is a cross-sectional statewide survey used to determine the prevalence of child and adolescent overweight status, as well as diet and physical activity behaviours of school-aged children in Texas, USA[17]. The SPAN study is unique in that it provides representative estimates of child weight status and energy balance-related behaviours, both at the state level and for each of the Texas Department of State Health Services' public health regions[17]. SPAN uses a stratified, multistage sampling plan to obtain state-representative data when stratified by race/ethnicity (African American, Hispanic and White/Other), gender, school grade (4th, 8th and 11th) and by Texas Health Service Region[17]. Approval for the SPAN study was obtained from the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston (UTHealth) and the Texas Department of State Health Services Institutional Review Board. Participating school districts also reviewed study protocols for compliance with school district human subjects and research regulations. Further descriptions of the SPAN study and methods are presented elsewhere[17–19].

### Participants

The SPAN 2009–2011 study surveyed three grade levels of public school students – 4th, 8th and 11th grades – with the aim of including distinct developmental stages of children in elementary, middle and high school. For the present study, only 8th and 11th grade student data were included, since the nutrition label question for 4th grade students assessed another aspect of label reading. Data obtained from the Texas Education Agency for public school enrolment during the 2009–2011 school years were used as the reference base for the sampling plan. The sampling frame for SPAN 2009–2011 included 3931 grade 8 and 2785 grade 11 students, representing 300 566 students in 8th grade and 260 780 students in 11th grade[19].

### Data collection

Study participants completed a self-administered questionnaire that was tailored to 8th/11th grade students. The questionnaires were adapted from the School-Based Nutrition Monitoring (SBNM) survey, which is an elementary-level and secondary-level surveillance instrument designed

to assess nutrition and physical activity behaviours and nutrition knowledge and attitudes[20–22]. The SPAN survey and protocols were developed, pilot tested and assessed for reproducibility as part of the SBNM project[20–22]. Data collection at both state and county levels was conducted by trained and certified project staff, with assistance from state and county personnel. Height and weight were objectively measured by study staff to determine BMI status. Demographic data for the students were self-reported and included gender and grade (8th or 11th). Self-reported race/ethnicity was collapsed, for analytic purposes, into three categories: African American, Hispanic/Latino or White/Other. White/Other included non-Hispanic White, Native American, Asian, Pacific Islander or 'other'[17]. Other race/ethnicity accounted for only 3 % of the total Texas population. Parents' education level was measured based on two survey items, which asked adolescents about the highest level of education their mother and father had completed. Mother's and father's education level was combined into a single variable and dichotomized as 'at least some college' (if at least one parent had completed some college, a college degree, or a graduate or professional degree) *v.* 'high school or less' (if both parents had only completed high school/General Educational Development or had completed less than high school). Socio-economic status (SES) was assessed at the school level, not the individual level, and was measured based on the percentage of students who received free and reduced-price lunches within the adolescents' schools.

### Measures

#### Nutrition label use
Nutrition label use was assessed by the question, 'Do you use food labels (Nutrition Facts) to make your food choices?' with responses broken down into four options: 'Yes, all of the time'; 'Yes, most of the time'; 'Yes, some of the time'; and 'Never'. Nutrition label use for the present study was then dichotomized into 'Yes' and 'No'.

#### Dietary intake
*Sugary beverages.* To assess sugary beverage consumption, the responses to two questions were combined: 'Yesterday, how many times did you drink any punch, Kool-Aid®, sports drinks or other fruit-flavoured drinks? Do not count 100 % fruit juice' and 'Yesterday, how many times did you drink any regular (not diet) sodas or soft drinks?' The response categories included: 0 times, 1 time, 2 times, 3 times, 4 times and 5 or more times for each question. For the present study's purpose, the responses for sugary beverage consumption were collapsed into two categories: (i) those who consumed no sugary beverages the previous day and (ii) those who consumed one or more sugar-sweetened beverages the previous day.

*Fruits and vegetables.* To determine how often the students consumed fruits and vegetables, five questions were used; see Table 1 for questions and answer choices. The responses to these questions were summed and collapsed into two groups: (i) those who consumed no fruits and vegetables the previous day and (ii) those who consumed one or more fruits and vegetables the previous day.

*Sweets.* Intake of sweets was measured by three questions; see to Table 1 for questions and answer choices. The responses to these questions were summed and collapsed into two groups: (i) those who consumed no sweets the previous day and (ii) those who consumed one or more sweets the previous day. We also looked at a second sweets variable: (i) those who consumed two or fewer sweets the previous day and (ii) those who consumed three or more sweets the previous day.

#### Healthy eating score
A healthy eating score was calculated to determine the healthfulness of the overall diet of the adolescent, based on the SPAN Healthy Eating Index[23]. To calculate this score, the responses to each question were dichotomized into '0 = No' or '1 = Yes', as in the adolescent did eat a certain food the previous day or did not eat it. Then certain questions were grouped based on whether they were describing a healthy item or an unhealthy item. Healthy foods consisted of thirteen items: nuts, milk, yoghurt, whole wheat (or brown) rice or pasta, whole-grain cereal, any type of vegetable, beans, fruit, 100 % fruit juice and water. Unhealthy foods consisted of twelve items: red meat, cheese, white bread, French fries, fruit-flavoured drinks, soda, diet soda, caffeine, frozen desserts, cakes, candy and restaurant food. Summary scores for unhealthy and healthy food indices were created using these items and then scaled so each ranged from 0 to 100 points. Unhealthy food scores were subtracted from the healthy food scores to create an overall healthy eating score, with possible range from −100 to 100.

#### Nutrition knowledge
Four questions from the SPAN survey were used to determine nutrition knowledge (Table 1). A total score was determined based on the number of questions that were answered correctly. One point was given for each answer that was correct. The score ranged from 0 to 4, with 4 being the highest score possible, meaning that all four questions were answered correctly.

### Statistical analysis
Sampling weights and adjustments for the SPAN survey have been previously reported elsewhere[17]. All statistical analyses for the SPAN data were performed using the statistical software package STATA version 13.0, utilizing survey weights. First, descriptive statistics were calculated, and differences in the frequency or mean of nutrition label use and dietary intake variables were examined by gender, grade, ethnicity, weight status, parent education level and SES, using Pearson $\chi^2$ tests and *t* tests. Multivariable

**Table 1** School Physical Activity and Nutrition (SPAN) questions used for the present analysis

| | Question | Possible answers |
|---|---|---|
| Sugary beverages | 'Yesterday, how many times did you drink any punch, Kool-Aid®, sports drinks or other fruit-flavoured drinks? Do not count 100 % fruit juice'<br>'Yesterday, how many times did you drink any regular (not diet) sodas or soft drinks?' | 0 times, 1 time, 2 times, 3 times, 4 times, 5 or more times |
| Fruits and vegetables | 'Yesterday, how many times did you eat any starchy vegetables like potatoes, corn or peas?'<br>'Yesterday, how many times did you eat any orange vegetables like carrots, squash or sweet potatoes?'<br>'Yesterday, how many times did you eat a salad made with lettuce, or any green vegetables like spinach, green beans, broccoli or other greens?'<br>'Yesterday, how many times did you eat any other vegetables like peppers, tomatoes, zucchini, asparagus, cabbage, cauliflower, cucumbers, mushrooms, eggplant, celery or artichokes?'<br>'Yesterday, how many times did you eat fruit? Fruits are all fresh, frozen, canned or dried fruits. Do not count fruit juice' | |
| Sweets | 'Yesterday, how many times did you eat a frozen dessert? (a frozen dessert is a cold, sweet food like ice cream, frozen yoghurt, an ice cream bar or a Popsicle®)'<br>'Yesterday, how many times did you eat sweet rolls, doughnuts, cookies, brownies, pies or cakes?'<br>'Yesterday, how many times did you eat any candy? COUNT chewy, gummy, hard or chocolate candy' | |
| Nutrition knowledge | 'How many total cups of fruits should you eat each day?' | At least 2†, At least 3, At least 4, At least 5, I don't know |
| | 'How many total cups of vegetables should you eat each day?' | At least 2†, At least 3, At least 4, At least 5, I don't know |
| | 'Which contains the most calories?' | One gram of protein, One gram of fat†, One gram of carbohydrate, I don't know |
| | 'If I am overweight I am more likely to have more health problems like cancer or heart disease' | True†, False, I don't know |

†Correct answer.

logistic regression was then used to determine the relationship between nutrition label use and sugary beverage consumption, fruit and vegetable consumption, and consumption of sweets. Linear regression was conducted to examine the relationship between nutrition label use and healthy eating score. All analyses were adjusted for grade, gender, ethnicity, weight status, SES, parents' education level and nutrition knowledge. Significance of results was based on $P < 0.05$.

**Results**

Demographics of the study population are presented in Table 2. The numbers of boys and girls were about even, with boys comprising 51 % of the sample. About half (47 %) of the sample were from the 11th grade. The racial/ethnic makeup of the sample consisted of 39·83 % White/Other, 14·61 % African-American and 45·56 % Hispanic children, and was similar across grade level. The majority (62 %) of the sample were at a healthy weight and the rest were classified as overweight (16 %) or obese (22 %). The majority of students in the sample went to schools with SES in either the lowest (37 %) or middle tertile (38 %), with only 25 % of the sample coming from schools in the highest tertile. Approximately 40 % of the sample had parents with at least some college education, while 60 % had parents whose highest educational level was high school or less.

**Table 2** Demographics of the School Physical Activity and Nutrition (SPAN) study adolescent population, Texas, USA, 2009–2011

| | Total (n 6716) | 8th Grade (n 3931) | 11th Grade (n 2785) |
|---|---|---|---|
| Age (years), mean | 14·88 | 13·42 | 16·54 |
| Gender (%) | | | |
| Boy | 50·9 | 51·2 | 50·6 |
| Girl | 49·1 | 48·8 | 49·4 |
| Ethnicity (%) | | | |
| White/Other | 39·8 | 38·3 | 41·6 |
| African American | 14·6 | 14·4 | 14·9 |
| Hispanic | 45·6 | 47·3 | 43·5 |
| BMI class† (%) | | | |
| Healthy weight | 62·0 | 59·6 | 64·7 |
| Overweight | 15·7 | 17·4 | 13·7 |
| Obese | 22·3 | 23·0 | 21·6 |
| Parent education (%) | | | |
| Some college or more | 40·3 | 44·3 | 35·6 |
| High school or less | 59·7 | 55·7 | 64·4 |
| Socio-economic status (%) | | | |
| Highest tertile | 25·0 | 29·8 | 19·6 |
| Middle tertile | 38·2 | 31·8 | 45·4 |
| Lowest tertile | 36·8 | 38·4 | 35·0 |
| Nutrition knowledge, mean | 1·51 | 1·56 | 1·45 |

†Overweight is BMI > 85th and < 95th percentile, while obese is BMI ≥ 95th percentile.

The frequencies of nutrition label use, sugary beverage consumption, fruit and vegetable consumption and sweets consumption are presented in Table 3 and are stratified by gender, grade, ethnicity, weight status, parent education,

**Table 3** Frequencies of nutrition label use and selected dietary behaviours in the School Physical Activity and Nutrition (SPAN) study adolescent population, Texas, USA, 2009–2011

| | Nutrition label use | | Sugary beverages | | Sweets | | Sweets | | Fruits and vegetables | | Healthy foods score (mean score) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No | Yes | 0 time/d | ≥1 times/d | 0–2 times/d | ≥3 times/d | 0 time/d | ≥1 times/d | 0 time/d | ≥1 times/d | |
| Gender (%) | | | | | | | | | | | |
| Male | 39·3 | 60·7 | 22·1 | 77·9** | 69·9 | 30·1 | 28·3 | 71·7 | 18·8 | 81·2 | −3·62 |
| Female | 39·7 | 60·3 | 32·4 | 67·6 | 73·0 | 27·0 | 24·9 | 75·1 | 16·0 | 84·0 | −2·07 |
| Grade (%) | | | | | | | | | | | |
| 8th | 35·0 | 65·0** | 26·8 | 73·2 | 72·2 | 27·8 | 23·7 | 76·3 | 17·5 | 82·5 | −1·80 |
| 11th | 45·0 | 55·0 | 27·6 | 72·4 | 70·5 | 29·5 | 30·0 | 70·0 | 17·3 | 82·7 | −4·07 |
| Ethnicity (%) | | | | | | | | | | | |
| White/Other | 34·4 | 65·6* | 32·8 | 67·2*** | 75·6 | 24·4 | 25·8 | 74·2 | 11·9 | 88·1*** | 0·21* |
| African American | 44·4 | 55·6 | 18·6 | 81·4 | 54·7 | 45·3*** | 21·2 | 78·8 | 19·5 | 80·5 | −7·34 |
| Hispanic | 42·4 | 57·6 | 25·0 | 75·0 | 73·1 | 26·9 | 29·1 | 70·9 | 21·6 | 78·4 | −4·11 |
| BMI classification (%) | | | | | | | | | | | |
| Healthy weight | 41·9 | 58·1 | 27·2 | 72·8 | 70·2 | 29·8 | 24·2 | 75·8* | 15·7 | 84·3 | −3·04 |
| Overweight | 35·4 | 64·6 | 31·5 | 68·5 | 75·5 | 24·5 | 30·0 | 70·0 | 19·8 | 80·2 | −1·14 |
| Obese | 35·7 | 64·3 | 23·9 | 76·1 | 71·9 | 28·1 | 30·9 | 69·1 | 20·6 | 79·4 | −3·55 |
| Parent education (%) | | | | | | | | | | | |
| Some college or more | 37·8 | 62·2 | 30·6** | 69·5 | 70·4 | 29·6 | 23·5* | 76·5 | 14·5* | 85·5 | −1·85 |
| High school or less | 41·3 | 58·7 | 20·9 | 79·1 | 70·4 | 29·6 | 27·8 | 72·2 | 18·7 | 81·3 | −4·07 |
| Socio-economic status (%) | | | | | | | | | | | |
| Highest tertile | 42·4 | 57·7 | 20·1* | 79·9 | 70·3 | 29·7 | 28·1 | 71·9 | 22·6 | 77·4 | −5·99 |
| Middle tertile | 45·5 | 54·5 | 27·5 | 72·5 | 67·7 | 32·3 | 29·5 | 70·5 | 18·0 | 82·0 | −2·72 |
| Lowest tertile | 31·7** | 68·3 | 31·6 | 68·4 | 76·0* | 24·0 | 22·6 | 77·4 | 13·3** | 86·7 | −0·88 |
| Nutrition knowledge (mean score) | 1·39** | 1·59 | 1·67*** | 1·45 | 1·53 | 1·45 | 1·46 | 1·52 | 1·46 | 1·52 | 0·05 |
| TOTAL | 39·5 | 60·5 | 27·2 | 72·8 | 71·4 | 28·6 | 26·6 | 73·4 | 17·4 | 82·6 | −2·86 |

To calculate the healthy foods score, the responses to each question were dichotomized into '0 = No' or '1 = Yes', as in the adolescent did eat a certain food the previous day or did not eat it. Then certain questions were grouped based on whether they were describing a healthy item or an unhealthy item. Summary scores for unhealthy and healthy food indices were created using these items and then scaled so each ranged from 0 to 100 points. Unhealthy food scores were subtracted from the healthy food scores to create an overall healthy eating score, with possible range from −100 to 100. Socio-economic status represents the school level, not the individual level, and was measured based on the percentage of students who receive free and reduced-price lunches within the school. For nutrition knowledge, a total score was determined based on the number of questions that were answered correctly. One point was given for each answer that was correct. The score ranged from 0 to 4, with 4 being the highest score possible, meaning that all four questions were answered correctly.
Pearson $\chi^2$ tests and $t$ tests were calculated to determine differences by categorical and continuous demographic variables, respectively: *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

SES and nutrition knowledge. Overall, 60·51% of adolescents in the sample self-reported that they used nutrition labels to make food choices. Nutrition label use did not differ by gender ($P > 0.05$). Nutrition label use did differ significantly between 8th and 11th grade, with 65% of 8th graders reporting the use of nutrition labels compared with only 55% of 11th grade students ($P < 0.01$). Among racial/ethnic groups, 66% of White/Other adolescents reported using nutrition labels to make food choices, compared with 56% of African-American adolescents and 58% of Hispanic adolescents ($P < 0.05$). Adolescents who were classified as overweight or obese reported using nutrition labels more often than adolescents who were classified as healthy weight, with about 65% of obese and overweight adolescents using nutrition labels compared with 58% of healthy-weight adolescents, although there were no significant differences ($P > 0.05$). Parents' education level was not significantly different across categories of nutrition label use, but SES was. Adolescents who came from schools in the lowest tertile for SES reported using nutrition labels more frequently (68·3%) than adolescents who came from schools in the middle (54·5%) or highest (57·6%) tertile

($P < 0.01$). Adolescents who reported using nutrition labels had a nutrition knowledge score of 1·59, which was significantly higher than the score of 1·39 among those who did not use nutrition labels ($P < 0.01$).

Sugary beverage consumption differed significantly across genders, with more boys (78%) consuming ≥1 sugary beverages/d than girls (68%; $P < 0.01$). Sugary beverage consumption also varied by ethnicity, with 81% of African Americans reporting consuming ≥1 sugary beverages/d compared with about 67% for White/Other and 75% for Hispanic adolescents ($P < 0.001$). Adolescents who reported having at least one parent with some college education or more (70%) consumed fewer sugary beverages than adolescents who reported that both parents only had a high school education (80%) or less ($P < 0.01$). Sugary beverage use did not vary by weight status or grade level. Adolescents who reported consuming 0 sugary beverages/d had a significantly higher nutrition knowledge score than those who reported consuming ≥1 sugary beverages/d ($P < 0.001$). Most (88%) of White/Other adolescents reported having ≥1 fruits and vegetables/d, compared with only 78% of Hispanic

adolescents and 81 % of African-American adolescents ($P < 0.001$). Adolescents who came from schools in the highest tertile consumed fewer (77 %) fruits and vegetables than adolescents in the middle (82 %) and lower tertiles (87 %; $P < 0.01$). Adolescents with parents who had some college education or more also consumed more fruits and vegetables (86 %) than adolescents with parents who had only a high school education or less (81 %; $P < 0.05$). Consumption of ≥1 sweets/d did not differ significantly by race/ethnicity, but consumption of ≥3 sweets/d did, with 24 % of White/Other adolescents and 27 % of Hispanic adolescents reporting having ≥3 sweets/d compared with 45 % of African-American adolescents ($P < 0.001$).

Adolescents who used nutrition labels had 1·7 times lower odds of consuming ≥1 sugary beverages/d ($OR = 0.59$, $P = 0.003$) and twice the odds of consuming ≥1 fruits and vegetables/d ($OR = 2.13$, $P = 0.001$) than adolescents who did not use nutrition labels (Table 4). There was no significant association between nutrition label use and consumption of ≥1 sweets/d. Adolescents who used nutrition labels had 1·4 times lower odds of consuming ≥3 sweets/d than adolescents who did not use nutrition labels ($OR = 0.69$, $P = 0.023$). Overall dietary intake was also associated with use of nutrition labels: adolescents who used nutrition labels had almost an 11-point higher healthy eating score compared with adolescents who did not ($\beta = 10.964$, $P < 0.001$).

Nutrition knowledge was significantly associated with nutrition label use. For every 1-point increase in nutrition knowledge, adolescents had 1·22 higher odds of using nutrition labels ($P = 0.005$). Nutrition label use did not differ significantly by gender ($P > 0.05$). Adolescents who were in the 11th grade had significantly lower odds of using nutrition labels compared with adolescents in the 8th grade ($OR = 0.66$, $P = 0.007$). When compared with White/Other adolescents, African-American adolescents were 1·5 times less likely to use nutrition labels ($OR = 0.66$, $P = 0.02$). Hispanic adolescents were 1·4 times less likely to use nutrition labels than White/Other adolescents, which approached significance ($OR = 0.71$, $P = 0.057$). Adolescents who came from the middle or highest tertile of school SES had significantly lower odds of using nutrition labels ($OR = 0.59$, $P = 0.001$; $OR = 0.66$, $P = 0.009$) when compared with adolescents from the lowest tertile. Nutrition label use also did not differ significantly by adolescents' weight status or parents' education level.

Girls had almost two times lower odds ($OR = 0.58$, $P = 0.007$) of consuming ≥1 sugary beverages/d than their male counterparts. Several racial/ethnic differences in dietary behaviours were noted (Table 4). For example, African-American adolescents had twice the odds of consuming ≥1 sugary beverages/d than did White/Other adolescents ($OR = 2.04$, $P < 0.001$). Hispanic ($OR = 0.55$, $P = 0.005$) and African-American ($OR = 0.62$, $P = 0.055$) adolescents had significantly lower odds of consuming ≥1 fruits and vegetables/d than White/Other adolescents.

African-American adolescents had 2·5 times higher odds of consuming ≥3 sweets/d than White/Other adolescents ($P < 0.001$). Adolescents who attended schools in the middle or upper tertile for SES had significantly higher odds of consuming ≥3 sweets/d than adolescents who attended schools in the lowest tertile ($OR = 1.58$, $P = 0.013$; $OR = 1.50$, $P = 0.025$). Adolescents who had at least one parent with some college education or higher had significantly lower odds of consuming ≥1 sugary beverages/d than adolescents whose parents both had a high school education or less ($OR = 0.58$, $P = 0.007$). For every 1-point increase in nutrition knowledge, adolescents had significantly lower odds of consuming ≥1 sugary beverages/d ($OR = 0.85$, $P = 0.013$).

## Discussion

The present study is the first to analyse a large, diverse and representative statewide sample to determine specific dietary patterns associated with nutrition label use among 8th and 11th grade adolescents in Texas. Adolescents are an important age group to study because of the greater autonomy that they develop throughout this period[9]. Adolescents make their own food choices, can influence foods that parents buy, and often have the opportunity to choose between different foods, especially snack foods[11]. Adolescents who used nutrition labels were less likely to consume sugary beverages and sweets daily, and more likely to consume more fruits and vegetables. In addition, adolescents who reported use of nutrition labels were more likely to consume healthier diets overall based on a healthy eating score.

To date, few studies have examined adolescent nutrition label use and dietary behaviour associated with use and non-use[14,15]. The majority of studies in this area have examined only adolescents' awareness of nutrition labels[15,16]. In particular, these studies have found that adolescents may have trouble understanding nutrition labels, which may lead to non-use[15,16]. In our study, about 60 % of students reported using nutrition labels to make food choices, so there is still a significant proportion of adolescents (about 40 %) in Texas who do not use nutrition labels as a tool to inform better eating choices.

An important finding in our study was the positive association between nutrition knowledge and nutrition label use. This finding is consistent with a number of other studies that found a positive association between self-report nutrition knowledge measures and self-reported nutrition label use[24–28]. Nutrition knowledge is an important variable in the present study because the more knowledgeable adolescents are about nutrition, the more likely they are to use nutrition labels[29]. However, nutrition knowledge may play a larger role in determining dietary behaviours, even without accounting for nutrition label use. Previous studies have shown associations between nutrition knowledge and

**Table 4** Associations between nutrition label use, covariates and dietary behaviours in the School Physical Activity and Nutrition (SPAN) study adolescent population, Texas, USA, 2009–2011

| | Nutrition label use | | | Sugary beverage consumption | | | Sweets consumption ≥1 times/d | | | Sweets consumption ≥3 times/d | | | Fruit and vegetable consumption | | | Healthy eating score | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OR | 95 % CI | P | OR | 95 % CI | P | OR | 95 % CI | P | OR | 95 % CI | P | OR | 95 % CI | P | β | 95 % CI | P |
| **Nutrition label use (ref. No)** | | | | | | | | | | | | | | | | | | |
| Yes | | | | 0·59 | 0·42, 0·84 | 0·003 | 1·10 | 0·93, 1·46 | 0·493 | 0·69 | 0·51, 0·95 | 0·023 | 2·13 | 1·49, 3·05 | 0·001 | 10·96 | 8·32, 13·61 | <0·001 |
| **Gender (ref. Boy)** | | | | | | | | | | | | | | | | | | |
| Girl | 0·99 | 0·76, 1·27 | 0·908 | 0·58 | 0·39, 0·861 | 0·007 | 1·16 | 0·91, 1·49 | 0·234 | 0·84 | 0·62, 1·14 | 0·260 | 1·13 | 0·82, 1·57 | 0·451 | 1·02 | −1·85, 3·90 | 0·482 |
| **Grade (ref. 8th)** | | | | | | | | | | | | | | | | | | |
| 11th | 0·66 | 0·49, 0·89 | 0·007 | 0·99 | 0·73, 1·37 | 0·995 | 0·73 | 0·50, 1·07 | 0·102 | 1·09 | 0·80, 1·47 | 0·593 | 1·12 | 0·78, 1·60 | 0·538 | −1·67 | −6·39, 3·06 | 0·486 |
| **Ethnicity (ref. White/Other)** | | | | | | | | | | | | | | | | | | |
| African American | 0·66 | 0·46, 0·94 | 0·020 | 2·04 | 1·50, 2·78 | <0·001 | 1·32 | 0·85, 2·04 | 0·214 | 2·52 | 1·69, 3·75 | <0·001 | 0·62 | 0·38, 1·01 | 0·055 | −5·77 | −10·72, −0·83 | 0·022 |
| Hispanic | 0·71 | 0·50, 1·01 | 0·057 | 1·40 | 1·06, 1·85 | 0·017 | 0·83 | 0·56, 1·24 | 0·363 | 1·12 | 0·82, 1·53 | 0·466 | 0·55 | 0·37, 0·83 | 0·005 | −2·67 | −6·56, 1·22 | 0·177 |
| **BMI classification (ref. Healthy weight)** | | | | | | | | | | | | | | | | | | |
| Overweight | 1·32 | 0·97, 1·79 | 0·075 | 0·83 | 0·56, 1·23 | 0·340 | 0·81 | 0·60, 1·08 | 0·151 | 0·78 | 0·57, 1·06 | 0·109 | 0·86 | 0·63, 1·18 | 0·351 | 1·67 | −2·44, 5·78 | 0·422 |
| Obese | 1·30 | 0·89, 1·92 | 0·176 | 1·12 | 0·77, 1·62 | 0·552 | 0·75 | 0·57, 0·99 | 0·047 | 0·94 | 0·59, 1·49 | 0·801 | 0·76 | 0·50, 1·15 | 0·188 | −0·40 | −3·76, 2·96 | 0·815 |
| **Parent education (ref. High school or less)** | | | | | | | | | | | | | | | | | | |
| Some college or more | 1·00 | 0·75, 1·32 | 0·978 | 0·58 | 0·39, 0·86 | 0·007 | 1·03 | 0·80, 1·30 | 0·843 | 0·99 | 0·74, 1·33 | 0·968 | 1·15 | 0·81, 1·62 | 0·776 | 1·88 | −0·72, 4·48 | 0·155 |
| **Socio-economic status (ref. Lowest tertile)** | | | | | | | | | | | | | | | | | | |
| Middle tertile | 0·59 | 0·43, 0·81 | 0·001 | 0·96 | 0·56, 1·65 | 0·872 | 0·75 | 0·48, 1·18 | 0·213 | 1·58 | 1·10, 2·26 | 0·013 | 0·88 | 0·62, 1·26 | 0·495 | −0·23 | −6·86, 6·40 | 0·946 |
| Highest tertile | 0·66 | 0·48, 0·90 | 0·009 | 1·44 | 0·88, 2·34 | 0·144 | 0·79 | 0·49, 1·28 | 0·332 | 1·50 | 1·05, 2·14 | 0·025 | 0·70 | 0·45, 1·09 | 0·116 | −3·54 | −10·34, 3·26 | 0·306 |
| Nutrition knowledge | 1·22 | 1·06, 1·40 | 0·005 | 0·85 | 0·75, 0·97 | 0·013 | 1·05 | 0·84, 1·33 | 0·593 | 0·98 | 0·84, 1·15 | 0·805 | 1·05 | 0·85, 1·31 | 0·634 | 0·41 | −1·19, 2·00 | 0·615 |

Ref., referent category.

To calculate the healthy foods score, the responses to each question were dichotomized into '0 = No' or '1 = Yes', as in the adolescent did eat a certain food the previous day or did not eat it. Then certain questions were grouped based on whether they were describing a healthy item or an unhealthy item. Summary scores for unhealthy and healthy food indices were created using these items and then scaled so each ranged from 0 to 100 points. Unhealthy food scores were subtracted from the healthy food scores to create an overall healthy eating score, with possible range from −100 to 100. Socio-economic status represents the school level, not the individual level, and was measured based on the percentage of students who receive free and reduced-price lunches within the school. For nutrition knowledge, a total score was determined based on the number of questions that were answered correctly. One point was given for each answer that was correct. The score ranged from 0 to 4, with 4 being the highest score possible, meaning that all four questions were answered correctly.

dietary behaviours[30–33]. The strong associations between nutrition label use and dietary behaviours found in the current study and the associations found between nutrition knowledge and dietary behaviours in the previous studies suggest that educational programmes targeting both nutrition knowledge and nutrition label use might be effective.

The present study is among the first to examine how nutrition label use is associated with sugary beverage consumption in adolescents. Sugary beverage consumption among adolescents has been a continuing concern because of the prevalence of these drinks in adolescent diets and the known potential for weight gain associated with excess consumption. Numerous studies have associated weight gain with higher consumption of sugary beverages[34–36]. In our study, almost three-quarters (73 %) of all 8th and 11th grade adolescents consumed one or more sugary beverages daily. In light of this, our findings indicated that adolescents who used nutrition labels to make their dietary decisions were significantly less likely to consume sugary beverages compared with those who did not. Although it is not possible to assess if use of nutrition labels causes reduction of sugary beverage consumption, it does appear that adolescents who use nutrition labels make conscientious decisions about their diets and may have a better understanding of the health risks associated with too much sugar.

Fruit and vegetable intake among adolescents is still low and does not meet the recommended daily requirements of about 2–3 cups of both fruits and vegetables daily[37,38]. Having a diet rich in fruits and vegetables is known to have numerous health benefits, such as reducing risks for many diseases and cancers and helping to manage body weight[39]. A systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight showed that the promotion of increased fruit and vegetable consumption resulted in either reduced weight gain or a reduction in body weight[40]. In light of this, results from our study showed that adolescents who used nutrition labels had higher odds of consuming one or more fruits and vegetables daily than adolescents who did not use nutrition labels. Although one study conducted in 1999 showed no association between label use and fruit and vegetable intake in adults[7], a more recent study conducted among college students in 2012 showed that frequent nutrition label readers had higher rates of meeting the daily recommendation for fruit and vegetable intake than non-frequent label readers[6]. It is possible that such associations are stronger among young people, whose dietary habits and practices may still be malleable. This finding is also noteworthy because fruits and vegetables do not have nutrition labels on them. The current study and other previous studies, mentioned above, have shown a strong correlation between nutrition knowledge and food label use; thus the finding of a significant association between nutrition label use and fruit and vegetable consumption may reflect that these adolescents are more knowledgeable and know the health benefits of consuming fruits and vegetables. It may be that those who use nutrition labels place an increased value on healthy eating and therefore have higher odds of consuming more fruits and vegetables.

Over the last three decades, added sugar consumption has increased by more than 30 % for American adults and 20 % for children[41]. It is known that a diet rich in added sugars increases excess energy and reduces nutrient density, causing weight gain and obesity[41]. Our study found that adolescents who used nutrition labels had significantly lower odds of consuming three or more sweets daily than those who did not use nutrition labels, but showed no significant difference in the odds of consuming one or more sweets daily. This finding is similar to that from a study in college students which showed students who frequently read nutrition labels were more likely to meet the daily recommendation for added sugar intake[6].

Several racial/ethnic differences in food consumption were seen in the current study. For example, African-American adolescents had significantly higher odds of consuming three or more sweets daily than White/Other adolescents, and were also more likely to consume sugary beverages compared with White/Other adolescents. These findings are consistent with findings from the Centers for Disease Control and Prevention, which showed that non-Hispanic Black men and women consumed a significantly larger percentage of their total energy from added sugars compared with non-Hispanic White and Mexican-American men and women[42]. Another study reported that African-American adolescents had 1·49 times higher odds of consuming sugary beverages than White/Other adolescents[43], which is similar to our results.

Texas adolescents who were classified as overweight were less likely to consume sugary beverages than those who were classified as healthy weight. In general, adolescents who are overweight tend to under-report foods high in fat and sugar[44]. However, it should be noted that BMI was a covariate in our analyses, so we did control for this. It could also be that adolescents who are overweight are trying to lose weight so they consume fewer sugary beverages; however, specific methods to lose weight or prevent weight gain were not assessed in the SPAN study.

Girls were found to have lower odds of consuming sugary beverages and this finding is consistent with previous studies[45,46]. Adolescents with parents who had some college education or a college degree were less likely to consume sugary beverages than those with parents with a high school education or less. This finding is consistent with a study conducted by Han and Powell, that examined trends in the consumption of sugary beverages in the NHANES from 1999 to 2008[43]. This shows the important role that parents and the household environment play in guiding adolescent health behaviours. Our study found that adolescents who attended schools in the middle or upper tertile for SES had significantly higher odds of consuming three or more sweets daily compared with adolescents who

attended schools in the lowest tertile. These results are in agreement with a study conducted on European adolescents which found a high intake of free sugars among high-SES adolescents[47]. Two other studies contradicted this and found no significant associations between SES and the consumption of sweets[48,49]. This inconsistency could have been caused by the different measures used to determine SES among the studies.

### Limitations and strengths

The present study does have some limitations. The cross-sectional study design prevents us from making any causal inferences between nutrition label use and dietary behaviour. A cross-sectional survey does, however, allow us to examine associations in a large and diverse statewide sample, to generate future hypotheses and develop intervention strategies to test. The measurements for dietary behaviour were obtained from self-report, which could lead to students misreporting nutrition label use or dietary behaviours. However, SPAN questions have been evaluated for reliability and validity in adolescent populations and cognitive interviews were used to determine interpretation[20–22,50]. The SPAN survey item tells us that adolescents use nutrition labels 'to make … food choices', but does not ask how often they have the opportunity to use nutrition labels or what aspect of the nutrition label they use. It may be that the relationship between reported nutrition label use and fruit and vegetable intake actually reflects an underlying value on eating healthily.

### Future directions

The current study is one of the first to examine how nutrition label use is associated with dietary behaviours among an ethnically diverse population of adolescents. Results from our study indicate that nutrition education efforts focusing on increasing nutrition knowledge and instilling core values in healthy eating, alongside efforts that focus on label reading and use, might help adolescents make healthful food choices. The release of the new nutrition labels in the USA by 2018 provides a window of opportunity to develop and promote these efforts with labels that more clearly reflect the nutritional content of foods.

In our study, 60 % of the respondents indicated that they did use nutrition labels, but these data do not tell us how much of the nutrition label they actually understood and what parts of the nutrition label were used to make their dietary decisions. One study found that the main elements of labels that adolescents used were the 'best before' date and the 'use by' date; however, these parts of the label are not nutrition information and are unrelated to dietary decisions[51]. The present study also indicated that nutritional information was not regarded highly by adolescents[51]. A recent study conducted by Graham and Roberto found that the new and modified Nutrition Facts label did not lead to more healthful purchase intentions than the existing nutrition labels in young adults[52]. However, their study focused solely on college students and was conducted in a laboratory setting. With new nutrition labels becoming mandatory in the USA by 2018, future research should focus on what parts of the new label are used by adolescents in a real-world environment. A study conducted by Rasberry et al. in 2007 revealed that college students mainly used nutrition labels for health reasons and for weight control and a reason for non-use of nutrition labels was time[53]. College students may feel that using nutrition labels is time consuming and that the loss of time outweighs the benefits of nutrition label use[53]. Future research should focus on reasons why adolescents use or do not use nutrition labels, to further tailor intervention and education programmes to help people effectively use nutrition labels. Attitude has been shown to mediate the effect between nutrition knowledge and nutrition label use, so programmes that instil positive attitudes about using nutrition labels may be helpful in increasing use[54]. It has also been shown, however, that adolescents can be persuaded into using nutrition labels through public service announcements[55] and they can successfully learn how to read and understand nutrition labels through educational sessions[56], so incorporation of these concepts into existing programmes could provide another lever for dietary changes that might in turn positively affect energy balance.

### Conclusion

Findings from the present study of 8th and 11th grade adolescents in Texas, USA indicate that nutrition label use is associated with healthier dietary behaviours. The new update to the nutrition label in 2018 should make it easier to understand and read, and provide additional environmental cues to guide consumers. However, changes in the environmental cues alone are unlikely to produce desired behavioural change, necessitating the implementation of behaviourally based nutrition education programmes that focus on increasing adolescent nutrition knowledge and strategies to effectively use nutrition labels to inform healthy dietary practices.

### Acknowledgements

*Conflict of interest:* None. *Authorship:* A.H. formulated the research question, performed background research, and wrote the manuscript. F.R.C. performed the statistical analysis, and reviewed and edited paper. N.R. contributed to the study design, directed the statistical analysis, and reviewed and edited paper. N.A. reviewed and edited paper. D.H. obtained funding, oversaw data collection, contributed to the study design, formulated the research question, directed the statistical analysis, and reviewed and edited paper. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center Houston (UTHealth) and the Texas Department of State Health Services Institutional Review Board. Written active or passive informed consent was obtained from all study participants.

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