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Depression and diet quality, US adolescents and young adults: National Health and Nutrition Examination Survey, 2015-March 2020

Cynthia L. Ogden, PhD, MRP^a [Analysis Branch Chief], Nicholas Ansai, MPH^a [Associate Service Fellow], Cheryl D. Fryar, MSPH^a [Health Statistician], Edwina A. Wambogo, PhD, MS, MPH, RD^b [Health Scientist Administrator], Debra J. Brody, MPH^a [Epidemiologist]

^aNational Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD

^bOffice of Dietary Supplements, National Institute of Health, Bethesda, MD

Abstract

Background: Depression is a common mental health disorder.

Objective: The objective of this study was to explore the association between diet quality, as measured by the Healthy Eating Index (HEI-2020), and depression symptoms among US adolescents and young adults, 12-29 years.

Design: The study design was a cross sectional secondary data analysis.

Participants: Data from the first 24-hour dietary recall for adolescents and young adults 12-29 years in the National Health and Nutrition Examination Survey 2015-March 2020 (n=4750) were analyzed.

Main outcome: Depression was defined as a score ≥ 10 from the Patient Health Questionnaire reflecting moderate or severe symptoms in the previous 2 weeks.

Statistical analyses performed: HEI-2020 total (range 0-100) and component scores were calculated for those with and without depression. Predicted HEI-2020 scores were estimated from linear regression models, adjusting for age, gender, race and Hispanic origin, family income, and seeing a mental health professional in the past year. Statistical analyses accounted for the complex sample design.

Results: The prevalence of depression among adolescents and young adults was 7.8% (95% confidence interval (CI) 6.3-9.5%). Total HEI-2020 score was 45.9 (95% CI 45.0-46.7) out of 100 on a given day during 2015-March 2020. Among young people with depression, total

Address correspondence to: Cynthia L. Ogden, National Center for Health Statistics/CDC, 3311 Toledo Rd, Hyattsville MD 20782 [cogden@cdc.gov].

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HEI-2020 score was lower than among those without depression (41.7 versus 46.2, $p<0.001$). After adjustment for covariates, the difference was attenuated but remained significant. In adjusted analyses, HEI-2020 component scores were lower for those with depression compared to those without depression for the adequacy components: Total Fruits (1.4 vs. 1.7 $p=0.03$), Whole Fruits (1.2 vs. 1.7 $p<0.01$), Total Vegetables (2.1 vs. 2.6 $p<0.01$), Greens and Beans (0.8 vs. 1.2 $p<0.01$), and Total Protein foods (3.6 vs. 4.0 $p=0.02$) out of maximum scores of 5. There were no statistically significant differences observed for Whole Grains, Dairy, Seafood and Plant Proteins, Fatty Acids, Saturated Fats, Refined Grains, Sodium, or Added Sugars.

Conclusion: Overall diet quality is low among young people. Diet quality, especially consumption of fruits, vegetables, and protein foods was lower among young people with depression compared to those without depression.

Keywords

Depression; diet quality; young people; US; NHANES

Depression is a common mental health disorder.^{1,2} In 2023, 4.5 million US adolescents 12-17 years, or 18.1% of this age group, experienced a major depressive episode.¹ The prevalence was similar (17.5%) among young adults 18-25 years.¹ Depression has been associated with poor diet in some populations.³⁻⁷ In a systematic review of depression among children and adolescents, comparisons were difficult due to differences in measurements and there were some inconsistencies in results, but the authors concluded there was “support for an association” between diet and mental health.⁷ In addition, there is some evidence that high quality diets could be used to prevent and treat depression and anxiety.⁸

Diet can influence physical health directly which can then impact mental health.⁹ Indirectly, diet can impact hormonal, neural and inflammatory systems that can be pathways to mental health.⁹ On the other hand, mental health can influence cravings, habits and situational factors that impact diet.⁹ In addition, some psychiatric medications are associated with weight gain, in part due to appetite changes.^{9,10}

Given that 1 in 5 young people experienced a major depressive episode in 2021, and that depression has been associated with poor diet, it is important to examine depression and diet in this population. In addition, to our knowledge, no study has investigated the association between diet quality (Healthy Eating Index, HEI-2020) and depression using the full Patient Health Questionnaire (PHQ-9) in both young adults and adolescents in the United States, nor has any study explored the relationship between the specific HEI-2020 components of diet quality and depression in this population. The objective of this study was to explore the association between diet quality, as measured by the HEI-2020, and depression among US adolescents and young adults.

METHODS

National Health and Nutrition Examination Survey (NHANES)¹¹ data from 2015-March 2020 were analyzed. NHANES is a national survey representative of the US civilian,

non-institutionalized population and has a complex, multi-stage sample design. Between 1999 and 2018 data were released every 2 years. Because of the COVID-19 pandemic, the 2019-2020 cycle was interrupted and the data for 2019-March 2020 were added to the 2017-2018 cycle and released as a nationally representative sample for 2017-March 2020.¹² For this analysis, data from 2015-2016 and 2017-March 2020 were combined to ensure sufficient sample size for adolescents and young adults.

NHANES included a home interview followed by a physical examination including biospecimen collection, questions on depression symptoms, and a 24-hour dietary recall interview in a mobile examination center (MEC). Details of the NHANES study design, implementation, data sets, analytic considerations, and other documentation are available online.¹¹ NHANES included oversampling of subgroups to improve the ability to provide estimates for certain groups such as non-Hispanic Asian (Asian), non-Hispanic Black (Black), and Hispanic persons.

The National Center for Health Statistics (NCHS) Ethics Review Board approved NHANES. Adults 18 years and older provided consent and adolescents 12-17 years provided documented assent. Parental consent was also obtained for adolescents. The examination response rate for adolescents and young adults 12-29 years was 60.3% for 2015-2016 and 47.3% for 2017-March 2020.¹³

Dietary Intake

Survey participants completed two 24-hour dietary recall interviews; one in person in the MEC and the second by telephone about 10 days later. These analyses used data from the first 24-hour recall to reflect population estimates on a given day. Type, quantity and source for all foods and beverages consumed during the previous 24 hours were collected using USDA's Automated Multiple-Pass Method.¹⁴ NHANES participants 12 and older self-reported their dietary intake. Details about dietary data quality control and methods are available on the NHANES website.¹¹ The USDA's Food Patterns Equivalents Database¹⁵ categorized NHANES food codes into components based on the Dietary Guidelines for Americans (DGA) 2020-2025.¹⁶

Diet quality

Diet quality was assessed using the Healthy Eating Index (HEI-2020),^{17,18} an index that assesses alignment with the DGA 2020-2025.^{19,20} Thirteen components make up the index. Dietary adequacy is reflected in components reflecting Total Fruits, Whole Fruits, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, and Fatty Acids (ratio of poly- and monounsaturated fatty acids to saturated fatty acids). Higher HEI-2020 scores for adequacy components reflect higher intakes. Moderation is recommended for the remaining four components: Refined Grains, Sodium, Added Sugars, and Saturated Fats.¹⁷ Higher HEI-2020 scores for moderation components reflect lower intakes. Total scores range from 0 to 100 based on summing component scores which range from 0 to 5 or 0 to 10. Better alignment with the DGA and a healthier diet is reflected in higher scores.¹⁹

Depression

During the MEC examination, participants answered a nine-item screening instrument, the Patient Health Questionnaire (PHQ-9), that asks about the frequency of nine symptoms of depression in the past 2 weeks.²¹ The frequency of each symptom was evaluated using a scale of 0 to 3 for responses “not at all,” “several days,” “more than half the days,” and “nearly every day.” Summary scores ranged from 0 to 27. For this analysis, a PHQ-9 symptom score of 10 or greater, a well-validated cut point reflecting moderate or severe reporting of symptoms,²¹ was used to define depression. No depression was defined as a PHQ-9 score of less than 10 based on report of mild, minimal or no symptoms.

Covariates

Covariates included in this analysis included self-reported gender (male/female), age group, race and Hispanic origin, family income, and whether the individual saw a mental health professional during the previous year (yes/no). Age groups included adolescents 12-19 years and young adults 20-29 years. During the home interview, race and Hispanic origin were self-reported and, for this analysis, categorized as non-Hispanic Asian (Asian), non-Hispanic Black (Black), non-Hispanic White (White), and Hispanic. These race and Hispanic origin groups were the only groups for which statistically reliable estimates could be obtained. Individuals reporting more than one race group were included in an “other” group and were not shown separately but were included in the total population. Income was categorized using the Federal Poverty Level (FPL), as less than 130%, 130% to 350% and greater than 350%. FPL is based on the income to poverty ratio, a measure of the annual total family income divided by the US Department of Health and Human Services poverty guidelines, after accounting for inflation and family size.¹¹ The lower cut point of 130% of the poverty level is the cut off for the Special Nutrition Assistance Program.²²

Statistical Analysis

Total HEI-2020 and dietary component scores based on Day 1 dietary recalls were estimated for adolescents and young adults. The Simple HEI Scoring Algorithm Per-Person method was used instead of the Population ratio method because the Per-Person method allows for adjustment for covariates.²³ Unlike the Multivariate Markov Chain Monte Carlo method, an analytic method to relate HEI and an outcome is only available for the Simple method.²⁴ This approach involves initially computing the ratio of HEI components to energy intake at the individual level and subsequently summing these individual component scores to determine each total HEI-2020 score.

HEI-2020 scores (total and component) were estimated (predicted) from linear regression models, adjusting for age, gender, race and Hispanic origin, family income, and seeing a mental health professional in the past year.²⁵ The predicted HEI-2020 component scores were scaled as a percentage of the maximum component score and then plotted on radar plots to visualize differences by depression status. The center point of the radar plot reflects a score of zero, while the maximum score for the component is reflected in the outer point of each axis. Perfect alignment with the DGA (a total score of 100) is reflected in a plot with all components at the outer point of the axis. A plot with many points closer to the center reflects a dietary pattern not consistent with the DGA 2020-2025.

All prevalence estimates were evaluated using the NCHS data presentation standards for proportions²⁶ and mean estimates were evaluated based on a relative standard error $\geq 30\%$. Differences in the prevalence of depression by population characteristic were assessed using t-statistics. Differences in HEI-2020 scores between those with and without depression were assessed using contrasts in regression models. Significance levels were set at $p < 0.05$.

Analyses used dietary day 1 sample weights which account for oversampling, non-response (including item non-response), non-coverage, and day of the week. Standard errors were estimates using Taylor series linearization. Analyses were conducted in SAS (SAS Institute), version 9.4²⁷ and SUDAAN (RTI International), version 11.0.4.²⁸

RESULTS

Among 5,669 NHANES participants 12-29 years during 2015-March 2020, 4,926 (87%) had valid dietary recall data and among these 4,750 (96%) had complete information on depression symptoms. The sample size for the adjusted predicted HEI score analyses was 4,259 due to missing data for income ($n=490$) and seeing a mental health professional in the past year ($n=1$).

During 2015-March 2020, 7.8% (95% confidence interval (CI) 6.3-9.5%) of adolescents and young adults reported symptoms indicating moderate or more severe depression in the previous 2 weeks (Table 1). The prevalence of depression was lower among males than females ($p < 0.001$), lower among Asian young people than among Black, Hispanic, or White young people ($p < 0.001$) and decreased with increasing family income ($p < 0.01$). The prevalence of depression among adolescents and young adults who saw a mental health professional in the past year was higher than among those who did not ($p < 0.001$).

The overall HEI-2020 score for adolescents and young adults was 45.9 (95% CI 45.0-46.7) on a given day (Table 1). HEI-2020 ranged from 43.7 (95% CI 42.4-45.0) among Black young people to 51.4 (95% CI 50.2-52.7) among Asian young people. Total HEI-2020 score was lower among adolescents and young adults with depression than among those without depression (41.7 versus 46.2, $p < 0.001$). Differences in HEI-2020 score by depression status were found among all subgroups except among Black young people and young people in the middle-income group (130% to 350% of the poverty level).

In unadjusted analyses, Total Fruits, Whole Fruits, Total Vegetables, Greens and Beans, Total Protein Foods, Seafood and Plant Proteins, and Added Sugars HEI-2020 component scores were lower among those with depression compared to those without depression on a given day (Table 2). After adjustment for gender, age, race/Hispanic origin, family income, and seeing a mental health care provider, differences by depression status in total HEI-score and component scores for Total Fruits, Whole Fruits, Total Vegetables, Greens and Beans, and Total Protein Foods remained. These component scores were lower among adolescents and young adults with depression compared to those without depression (Figure).

DISCUSSION

During 2015-March 2020, diet quality on a given day as measured with the HEI-2020 were 4 points lower among US adolescents and young adults with depression than among those without depression. The difference was explained by lower scores for fruits, vegetables, and protein (adequacy components of the HEI) among young people with depression although differences were small. This difference was not related to differences in gender, age, race/Hispanic origin, income, or seeing a mental health care provider.

The association between overall diet quality and mental health has been investigated in different populations. A systematic review found a positive association between healthy dietary patterns and better mental health, including reduced depression, among children and adolescents, but it did not include young adults.²⁹ Another systematic review³⁰ found that a higher quality diet was associated with lower risk of depressive symptoms, but most of the papers in this review were studies of adults. In a study of the association between depressive symptoms (PHQ-2) and HEI-2005 among SNAP participants there was a significant inverse association, although the sample size was small (n=639).³¹ Two studies have used NHANES data to examine the association in US adults. Analyses of 2009-2010 data found that consumption of healthy foods such as fruits and vegetables was associated with reduced odds of depression.³ In another study, US adults with a higher HEI-2015 score had lower odds of depression during 2005-2016.³² These studies did not report results for the separate components of the HEI-2015, nor did they include adolescents, but the current analysis supports these previous findings.

Specific dietary components may be associated with depression. In the current analysis of US adolescents and young adults, dietary component scores for fruits and vegetables were shown to be inversely associated with depression among adolescents and young adults, even after accounting for demographic factors and healthcare seeking behavior. Similar to our results, in at least one study, fruit and vegetable consumption as part of a healthy diet was inversely associated with depression.³³ In a longitudinal study in the US, fruit and vegetable consumption during adolescence was not associated with depression in adulthood after adjusting for covariates.³⁴ A systematic review of fruit and vegetable consumption and common mental disorders found no significant association (based on 3 prospective cohort studies outside of the US).³⁵ Intake of fruits and vegetables in the US is generally low; more than 80% of the US population consume less than the recommended amount of fruits and vegetables.¹⁶ Studies have shown higher intake of fruits and vegetables has various health benefits including reducing the risk of some cancers and cardiovascular disease.³⁶

Fruits and vegetables contain various nutrients that have been associated with improved mental health.^{37,38} For example, many fruits and vegetables contain high levels of phytochemicals like flavonoids,³⁹ as well as antioxidants. These compounds may have neuroprotective effects, that are potentially^{37,38} associated with lower risk of depression. Additionally, many fruits and non-starchy vegetables have a low glycemic index.⁴⁰ High glycemic index foods lead to rapid spikes and crashes in blood sugar levels which can destabilize mood and have been reported to be associated with depression.⁴¹ Furthermore,

the fiber found in fruits and vegetables plays a critical role in promoting a healthy gut microbiome, which has been associated with lower risk of depression.⁴²

Protein intake was also inversely associated with depression in the current analysis. Similarly, in an analysis of Vietnamese young women, better global diet quality score and protein intake were inversely associated with depression.⁴³ Generally, in the US, protein intake is adequate.¹⁶

In contrast to the significant associations between fruits, vegetables and protein and depression found in this analysis, there was no association between added sugar intake and depression after adjusting for covariates. Some studies have found an association between added sugar intake and high glycemic index and depression in adults.^{41,44} In the current analysis of adolescents and young adults, small differences in added sugar intake by depression status were not significant after accounting for demographic characteristics and utilization of mental health services. The small sample size may have resulted in a lack of statistical power to observe a statistically significant difference in the adjusted model.

The relationship between psychiatric medications and diet is complex. There are no studies we are aware of that examine diet quality and medications, however there is an association between weight gain and the use of certain medications.^{9,45} The proposed mechanisms for this relationship relate to appetite but also to abnormal metabolic processes without a change in appetite or food intake.⁹ In our analysis, we accounted for current use of mental health services, a covariate that would be correlated with prescription medication use.

This study has some limitations and strengths. First, self-reported dietary intake data has been shown to systemically under report energy.^{46,47} Moreover, the HEI scores were calculated using data from a single day of dietary intake, which does not account for fluctuations in intake over time, and the method used does not account for measurement error.²³ Nevertheless, the Simple Scoring Method for calculating HEI, based on 1 day of dietary recall, is the available analytic method for investigating the association between HEI and an outcome, which was the objective of this study. Second, NHANES is a cross sectional study so causality cannot be determined. Reverse causality is possible.⁴⁸ Third, other potential confounders, such as physical activity and additional measures of socioeconomic status (SES), were not included. Physical activity and education are not measured in NHANES in the same way for adolescents and young adults. Moreover, NHANES has limited SES variables. Finally, depression can be defined over different time periods, limiting comparability of studies. Prevalence of a major depressive episode reported by the National Survey on Drug Use and Health is based on symptoms over the past year.¹ In this analysis, depression was defined using a validated screening instrument reflecting symptoms during the previous 2-weeks,²¹ but was not confirmed by diagnostic interview or consideration of antidepressant medication use. Antidepressant medication use may control symptoms of depression and thus the definition of depression used in this study may not reflect the true prevalence of depression. However, in a recent meta-analysis, more than half of young people on medication saw no improvement in depression symptoms.⁴⁹ Strengths of this study include the use of nationally representative data, a focus on young persons

who have rising rates of depression,⁵⁰ use of the most recent HEI-2020 scoring system, and analysis of the specific components of a healthy diet.

Conclusions

Diet quality on a given day, as measured by the HEI-2020 score, was lower among US adolescents and young adults with depression compared to those without depression. Young people with depression had slightly lower HEI-2020 component scores for fruits, vegetables, and protein foods.

Acknowledgments

The findings and conclusions in this report are those of the authors and do not necessarily reflect those of the Centers for Disease Control and Prevention or the National Institutes of Health.

Abbreviations:

CDC	Centers for Disease Control and Prevention
NCHS	National Center for Health Statistics
NHANES	National Health and Nutrition Examination Survey

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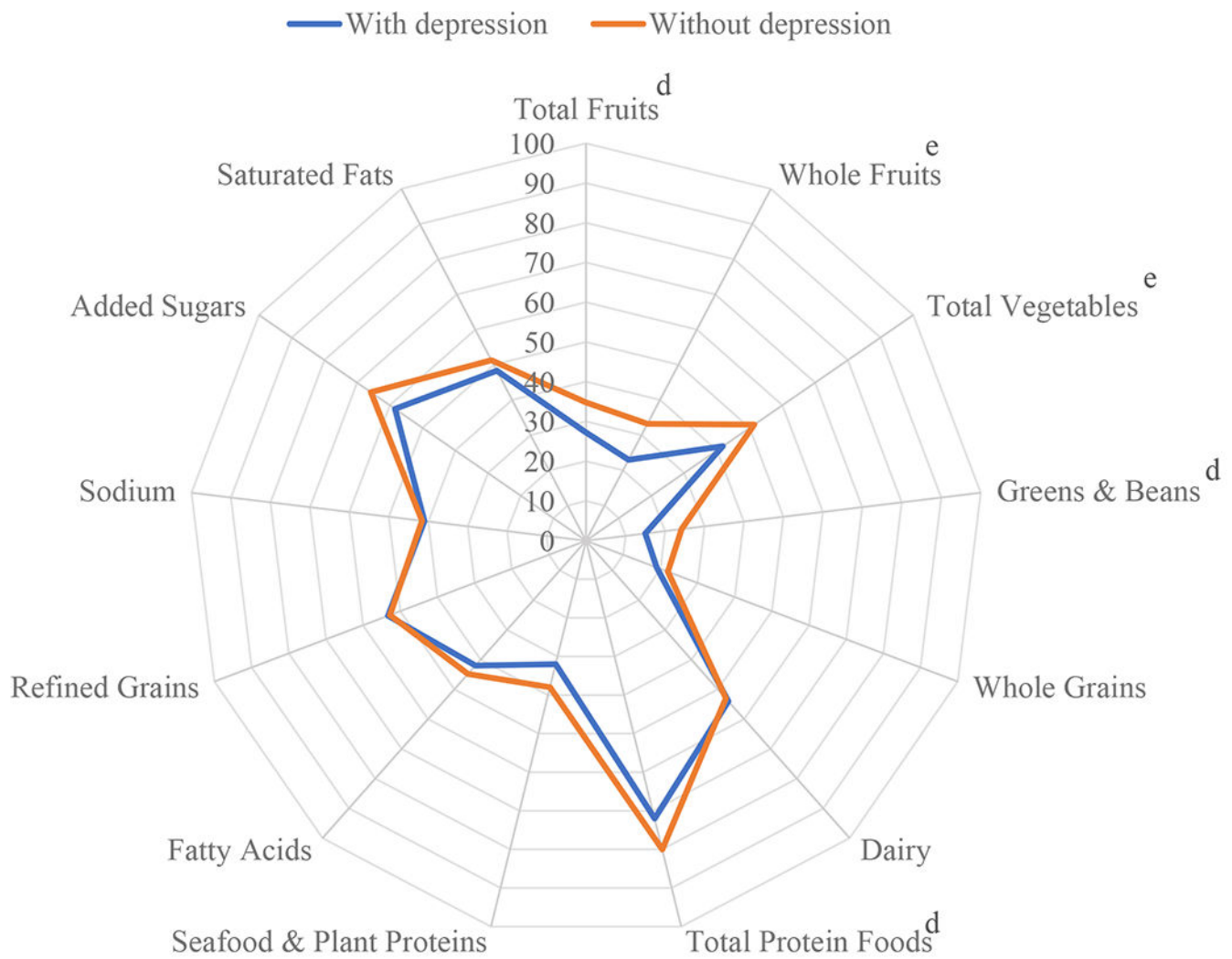
Research Snapshot

Research Question:

Is there an association between diet quality, as measured by the Healthy Eating Index (HEI-2020), and depression among US adolescents and young adults, 12-29 years?

Key Findings:

Based on data from the National Health and Nutrition Examination Survey, the prevalence of depression among adolescents and young adults was 7.8% and total HEI-2020 score was 45.9 out of 100 on a given day during 2015-March 2020. Diet quality on a given day, especially consumption of fruits, vegetables, and protein foods, was statistically significantly lower among young people with depression compared to those without depression, although the differences were small.

**Figure.**

Healthy Eating Index (HEI)-2020 component score by depression status, US adolescents and young adults 12-29 years, 2015-March 2020.^{a-c} ^aData source is the National Health and Nutrition Examination Survey. ^bThe predicted HEI-2020 component scores were scaled as a percentage of the maximum component score. ^cScores adjusted for age group, gender, race and Hispanic origin, family income and whether the person had seen a mental health care professional in the previous year. Significant difference between individuals with and without depression (^d $p < 0.05$ for Total Fruits, Greens & Beans, and Total Protein Foods; ^e $p < 0.01$ for Whole Fruits and Total Vegetables)

Table 1.

Prevalence of depression and predicted total HEI-2020 score by depression status, US Population ages 12-29 years, 2015-March 2020^{a,b}

	Sample size	Depression prevalence			Mean HEI-2020 score on a given day					p-value
		Percent	95% CI	All	95% CI	With depression	95% CI	without depression	95% CI	
Total ^c	4750	7.8	6.3-9.5	45.9	45.0-46.7	41.7	40.0-43.3	46.2	45.3-47.1	<0.001
Gender										
Male ^d	2364	5.8	4.0-7.9	44.9	44.0-45.7	39.8	37.3-42.2	45.2	44.3-46.1	<0.001
Female	2386	9.9	8.0-12.2	46.9	45.9-48.0	42.9	40.4-45.4	47.3	46.1-48.6	<0.01
Age (years)										
12-19	2838	7.1	5.6-8.9	44.5	43.7-45.3	41.7	39.3-44.0	44.7	43.8-45.5	0.02
20-29	1912	8.3	6.2-10.9	47.0	45.9-48.0	41.8	39.5-44.1	47.5	46.3-48.6	<0.001
Race/Hispanic origin										
Asian ^e	505	2.4	1.2-4.3	51.4	50.2-52.7	46.5	41.7-51.2	51.8	50.4-53.2	0.04
Black ^{e,f}	1174	7.6	5.6-10.1	43.7	42.4-45.0	43.2	39.9-46.5	43.7	42.3-45.1	0.78
White ^{e,f}	1437	8.5	6.3-11.2	45.7	44.5-46.8	41.1	39.0-43.2	46.0	44.7-47.3	<0.001
Hispanic ^{e,f}	1315	7.1	5.2-9.5	46.4	45.4-47.4	41.6	38.1-45.0	46.84	45.8-47.9	<0.01
Family Income ^{g,h}										
<130% Federal poverty level	1602	11.6	8.1-16.1	44.3	43.1-45.5	40.3	37.6-43.0	44.9	43.7-46.1	<0.01
130-350% Federal poverty level	1667	7.8	5.9-10.1	46.5	45.3-47.7	44.2	41.2-47.2	46.7	45.4-47.9	0.10
>=350% Federal poverty level	991	5.1	3.2-7.7	46.5	45.4-47.5	42.0	38.3-45.6	46.8	45.6-47.9	0.03
Seen mental health professional/past yr ^h										
Yes ⁱ	569	19.8	15.1-25.3	44.8	42.7-46.9	42.4	40.0-44.7	45.4	43.1-47.7	0.04
No	4180	6.0	4.7-7.6	46.1	45.3-46.9	41.4	39.3-43.5	46.3	45.5-47.2	<0.001

CI: confidence interval

^aSource: National Health and Nutrition Examination Survey^bSample size is unweighted and all other estimates are weighted^cTotal includes all other race and Hispanic origin groups not reported separately

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- p Depression prevalence significantly different than female, $p<0.001$
- e non-Hispanic
- f Depression prevalence significantly different than Asian, $p<0.001$
- g Depression prevalence significant decreasing linear trend, $p<0.01$
- h Does not sum to total due to missing data
- i Depression prevalence significantly different than having not seen a mental health professional, $p<0.001$

Unadjusted and adjusted predicted HEI-2020 overall and component scores on a given day by depression status, US Population ages 12-29 years, 2015-March 2020^a

Table 2.

	Unadjusted			Adjusted ^b				
	With depression	95% CI	without depression	95% CI	With depression	95% CI	without depression	95% CI
Total HEI-2020 score	41.7	40.0-43.3	46.2	45.3-47.1	<0.001	42.2	40.5-44.0	46.2
Adequacy								
Total Fruits ^d	1.3	1.0-1.5	1.7	1.6-1.9	0.003	1.4	1.0-1.7	1.7
Whole Fruits ^e	1.0	0.8-1.3	1.7	1.5-1.8	<0.001	1.2	0.9-1.5	1.7
Total								
Vegetables ^f	2.1	1.8-2.4	2.6	2.5-2.7	0.003	2.1	1.8-2.4	2.6
Greens & Beans	0.7	0.5-1.0	1.3	1.1-1.4	0.001	0.8	0.5-1.1	1.2
Whole Grains	1.7	1.3-2.1	2.1	2.0-2.3	0.096	1.9	1.5-2.3	2.2
Dairy ^g	5.3	4.7-6.0	5.3	5.1-5.5	0.872	5.4	4.7-6.1	5.3
Total Protein								
Foods ^f	3.5	3.3-3.8	4.0	3.9-4.1	0.004	3.6	3.4-3.9	4.0
Seafood & Plant Proteins ^h	1.5	1.2-1.8	1.9	1.8-2.1	0.016	1.6	1.2-1.9	1.9
Fatty Acids ⁱ	4.2	3.5-4.8	4.5	4.4-4.7	0.324	4.2	3.5-4.8	4.5
Moderation								
Refined Grains	5.3	4.8-5.9	5.2	5.1-5.4	0.719	5.3	4.8-5.9	5.3
Sodium	4.4	3.7-5.1	4.2	4.0-4.4	0.505	4.1	3.3-4.9	4.2
Added Sugars	5.7	4.9-6.5	6.6	6.4-6.7	0.031	5.8	5.0-6.7	6.6
Saturated Fats	4.8	4.2-5.4	5.2	5.0-5.4	0.191	4.8	4.2-5.4	5.1

CI: confidence interval

^aSource: National Health and Nutrition Examination Survey

^bAdjusted for gender, age group, race/Hispanic origin, family income, and seeing a health care provider in the previous year

^cBased on contrast statements in regression models

^dIncludes 100% fruit juice.

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^eIncludes all forms except juice.
^fIncludes beans, peas, and lentils.
^gIncludes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.
^hIncludes seafood, nuts, seeds, soy products (other than beverages), and beans, peas, and lentils.
ⁱRatio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).