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Original Research

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Adolescent Children's Risk of Long COVID-19 Syndrome Based on Diet and Demographic Factors From an Online Survey of Parents

Christopher Waskewich, PhD
Walden University, Minneapolis, Minnesota, United States
https://orcid.org/0009-0002-3074-7140

Contact: *cwaskew25@msn.com*

Abstract

Limited information is available on how coronavirus disease 2019 (COVID-19) has affected adolescents regarding long-term health risks. This quantitative study focused on the effect of U.S. adolescents' daily diet, race/ethnicity, levels of income, family level of education, access to health care, age, and comorbidities on the risks of long COVID-19 syndrome. I used the constructs of the health belief model to understand the impact of those variables. The online survey results (N = 298) found that adolescents whose daily vegetable consumption was more than daily recommendations (2–3 cups) had a lower odds ratio of having long COVID-19 syndrome (OR = 0.03) when compared to adolescents whose daily vegetable consumption was below daily recommendations (OR = 23.6). Chi-square analysis and bivariate logistic regression found the following predictors of long COVID-19 syndrome for adolescent children: daily consumption level of vegetables, families of lower middle class, not having insurance coverage in the past 12 months, not having money to pay medical bills, not visiting a doctor often for a physical checkup, and not visiting a doctor because of cost. The findings suggest that improving (a) adolescents' daily consumption of vegetables and (b) families' access to health care and education may help reduce adolescents' odds of having long COVID-19 syndrome. Using these findings with the health belief model, public health stakeholders may be able to formulate strategies to improve adolescents' diet and access to health care, both of which may help to reduce rates of long COVID-19 syndrome.

Keywords: *long COVID-19 syndrome, diet, adolescents*

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Introduction

The beginning of the coronavirus disease 2019 (COVID-19) pandemic started with the first cases of respiratory infections from the virus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) in Wuhan, China, in December 2019 (Chow & Englund, 2022; Kopel et al., 2020). In the United States, the virus has been responsible for 6.5 million hospitalizations due to COVID-19 infection and 1.1 million deaths since December 2019 (Centers for Disease Control and Prevention, 2024, 2025). Some people who have recovered from acute COVID-19 still experience symptoms for 4 months or longer (Hojyo et al., 2020; Yong, 2021). This condition is called "long COVID-19 syndrome," "post–COVID-19," or "long-haul syndrome" (Yong, 2021). These symptoms can last for 4 to 12 weeks and can include headaches, cognitive difficulties, loss of olfactory senses, sore throat, and myalgia (Behnood et al., 2022; Yong, 2021).

Literature Review

Data on mortality and morbidity from COVID-19 infection have shown major health disparities based on race/ethnicity (Baumer et al., 2020; Kopel et al., 2020; Lo et al., 2021). From January 2020 to May 2020, 25% percent of fatal COVID-19 infections in the United States affected individuals of African American descent (Gelaye et al., 2020). Those of Hispanic descent comprised 33% of the cases of COVID-19 in the United States, even though only 18% of the U.S. population was Hispanic (Gelaye et al., 2020). Socioeconomic factors (e.g., income level, race/ethnicity, family level of education) are known to play a role in health disparities (Zakeri et al., 2020). However, it is not completely understood why these health disparities have contributed to severe morbidity in terms of causing some people to have long COVID-19 syndrome and what factors may have played a role in that disparity (Gelaye et al., 2020; Lo et al., 2021; Lopez-Leon et al., 2022; Munblit et al., 2021).

Diet and specific nutrients have been found to affect a person's immune system and their risk of infection from diseases like COVID-19 (Childs et al., 2019). Merino et al. (2021) found that diets centered on foods derived from plants were associated with people having a lower risk of morbidity from COVID-19 infection. Poor nutrition contributed to higher risks of having severe COVID-19 infection, which can lead to severe morbidity and possible mortality, Merino et al. (2021) found. The impact of daily diet and the availability of fruits and vegetables has not been thoroughly studied to learn how certain diets cause children to be more vulnerable to COVID-19 morbidity, which can contribute to long COVID-19 syndrome (Barrea et al., 2022; Lopez-Leon et al., 2022; Merino et al., 2021; Munblit et al., 2021). The health factors contributing to these long-term effects are unclear for children and young people (Behnood et al., 2022). Research needs to be conducted to understand how social determinant factors may affect adolescent children's risks of having long COVID-19 syndrome and how demographic factors may contribute to that risk for children in the United States (Barrea et al., 2022; Merino et al., 2021; Munblit et al., 2021).

Purpose of the Study, Research Questions, and Hypotheses

The purpose of this research was to determine the role daily diet and demographic factors may play in children's risk of having long COVID-19 syndrome in the United States (Barrea et al., 2022; Merino et al., 2021; Munblit et al., 2021). The research question for this study examined whether there was an association between race/ethnicity, levels of income, level of education, access to health care, age, comorbidities, and daily consumption levels of fruits and vegetables and the risks of children having long COVID-19 syndrome. It was hypothesized, in this study, that if children of different races/ethnicities were compared for levels of income, levels of education, access to health care, age, comorbidities, and daily consumption level of fruits and vegetables, significant differences would exist regarding the risks of having long COVID-19 syndrome.

Methods

I surveyed parents of adolescent children aged 11–17 years in metropolitan New York City who had an acute COVID-19 infection. I needed 150 participants for this study to achieve a power size of 0.8 and a type 1 error rate of < 0.05 using GPower 3.1. The Walden University Institutional Review Board approved the study (Approval No. 04-11-24-1028170).

Participants

I recruited 403 participants through advertising on social media platforms, including Facebook, Instagram, YouTube, and TikTok, and administered the survey through SurveyMonkey.

Instrumentation

Questions from the National Health Interview Survey, the International Severe Acute Respiratory and Emerging Infection Consortium (ISARIC), the Five A Day Food Frequency Questionnaire (FADFFQ), and the Household Pulse Survey (Centers for Disease Control and Prevention, n.d.; Di Noia & Contento, 2009; ISARIC, 2021; Grantham et al., 2024) were used for this study.

ISARIC is an international research initiative created to prevent disease outbreaks (ISARIC, 2021). I used the questions from the ISARIC survey to determine a participant's well-being and whether they currently had or have had long COVID-19 syndrome (ISARIC, 2021). The questions from the Household Pulse Survey determined the types of symptoms of long COVID-19 that the children of participants may be having (Grantham et al., 2024. The questions from the FADFFQ determined a participant's daily consumption level of fruits and vegetables based on the number of servings per time period (e.g., day, month, or week; Di Noia & Contento, 2009). I used the questions from the National Health Interview Survey to collect information about a participant's age, race/ethnicity, level of income, access to health care, and whether the participant had any comorbidities (Centers for Disease Control and Prevention, n.d.).

I created the independent variables of daily consumption levels of fruits and vegetables based on the daily recommended guidelines for fruit and vegetable consumption for adolescents (U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2020). I created three categories, which were "met daily recommendations," "below the daily recommended guidelines," and "above the daily recommendations." I used the independent variable levels of income to create the variable socioeconomic status. Socioeconomic status was represented by four categorical variables: lower class, lower middle class, middle class, and upper middle class.

Access to health care had five different independent variables. The first variable was based on whether there was a time in the past 12 months when the family did not have insurance coverage, which was answered by "no—did not have loss of insurance coverage during the past 12 months" or "yes—did have a loss of insurance coverage in the past 12 months." The second variable was based on whether the family had problems or were unable to pay medical bills in the past 12 months, which were answered by "no—did not have trouble paying medical bills in the past 12 months" or "yes—did have trouble paying medical bills in the past 12 months." The third variable was based on how long it had been since the participant saw a doctor for a general checkup. The variables included often (have seen a doctor within the past year), not often (have seen a doctor within the past 2–10 years or more), and not at all (have never seen a doctor). The fourth variable was based on how long it had been since the participant saw a doctor for a physical checkup. The variables included often (seen a doctor within the past year), not often (seen a doctor within the past 2 years or more), and not at all (have never seen a doctor). The fifth variable was based on whether the family did not get medical care in the past 12 months because of cost, which was answered by "no—the family did not skip getting medical care because of cost in the past 12 months" or "yes—the family did not get medical care because of cost in the past 12 months."

The variable “parents’ highest level of education” includes four categories: less than high school, high school diploma, college degree, and graduate degree. Having a comorbidity was based on answers provided to the questions about the health of a child before having had acute COVID-19. The questions asked whether the child was overweight/obese or had diabetes, anxiety/depression, attention-deficit/hyperactivity disorder, chronic lung disease, asthma, or kidney disease. An answer of “yes” to any of the questions indicated that the adolescent a comorbidity, and an answer of “no” indicated that they did not have a comorbidity.

Data Collection

I administered the survey through the online platform SurveyMonkey, which distributed the survey to the participants and collected the responses. Participants received a $10 electronic gift card for participating in the survey.

Data Analysis

To determine the frequency of the variables, odds ratios, standard error, and statistical significance, I used IBM SPSS Statistics 28.0 for statistical analysis. I used chi-square analysis to determine the odds of having long COVID-19 syndrome based on the independent variables of access to health care (frequency of visiting a doctor for a general checkup, frequency of visiting a doctor for a physical checkup), daily intake of fruits, and daily intake of vegetables. I used cross-tabulation to determine the frequency distribution of the dependent variable and the independent variables: levels of income, access to health care, age, comorbidities, parents’ level of education, and daily intake of fruits and vegetables, with the independent variable race/ethnicity. To calculate the odds of having long COVID-19 syndrome based on the independent variables of age, race/ethnicity, levels of income, family level of education, access to health care, comorbidities, and daily intake of fruits and vegetables, I used bivariate logistic regression.

Results

Participant Characteristics

I administered the survey from April 13–17, 2024. A total of 458 adolescent parents filled out the survey, and 403 completed it. Based on incomplete answers, duplicate responses, and participants spending less than 4 minutes on the survey, I eliminated 105 participants (Gitlin, 2025). A total of 298 participants, who were part of the descriptive statistical analysis, completed the survey for a completion rate of 65%.

Table 1 shows the frequency distribution and percentages of dependent and independent variables (i.e., age, race/ethnicity, daily diet, levels of income, family's highest levels of education, and comorbidities). Of the total participants, under 10% reported that their child did not have long COVID-19 syndrome, compared to over 90% who reported that their child had long COVID-19 syndrome (see Table 1).

Adolescents were aged 11–17 years with an average age of 13.89 ±1.627 years. The largest number of adolescents were those who were age 14 (n = 67; 22.5%), while the fewest number of adolescents were those who were age 17 (n = 20; 6.7%). The race/ethnicity distribution of the adolescents was as follows: over 60% were of European American descent, just over 23% were African American, almost 5% were American Indian, 1.0% were Alaska Native, 1.0% were Asian, just over 8% were Hispanic, and under 1% were of some other race (see Table 1).

Table 1 also shows, regarding vegetable consumption, that 14% of participants met or were above the daily recommendation, while nearly 90% did not meet the daily recommendation. Additionally, a total of 123

adolescents (just over 40%) met or were above the daily recommendation for fruit consumption, while 175 (nearly 60%) did not meet the daily recommendation for fruit consumption.

Regarding the participants' family level of income, in Table 1, most of the participants (148, 49.7%) were lower middle class, while the fewest were upper middle class (32, 10.7%). Additionally, when evaluating the parents' highest level of education, over 50% of the participants had a high school diploma and under 10% had a graduate degree. Finally, in terms of comorbidities, Table 1 shows that just under half of the children of participants had a least one, while over 50% of children of participants did not have any comorbidity.

Table 1. *Frequency Distribution and Percentages of Dependent and Independent Variables (Age, Race/Ethnicity, Daily Diet, Levels of Income, Family Highest Levels of Education, and Comorbidities)*

Variable (type)	*n*	%
COVID-19 syndrome diagnosis (nominal dependent)		
Not having long COVID-19 syndrome	24	8.1
Having long COVID-19 syndrome	274	91.9
Age (years; independent)*		
11	25	8.4
12	43	14.4
13	54	18.1
14	67	22.5
15	56	18.8
16	33	11.1
17	20	6.7
Race/ethnicity (independent)		
White (European American)	184	61.7
African American	69	23.2
American Indian	14	4.7
Alaska Native	3	1.0
Asian	3	1.0
Hispanic	24	8.1
Some other race	1	0.3
Daily consumption level of vegetables (independent)		
Below daily recommendation	256	85.9
Meets daily recommendation	39	13.1
Above daily recommendation	3	1.0
Daily consumption of fruit (independent)		
Below daily recommendation	175	58.7
Meets daily recommendation	114	38.3
Above daily recommendation	9	3.0
Level of income (socioeconomic status; independent)		
$39,400 or less (lower class)	44	14.8
$39,401–$75,000 (lower middle class)	148	49.7
$75,001–$100,000 (middle class)	74	24.8
$100,001 or more (upper middle class)	32	10.7
Parents' highest level of education		
Less than high school	24	8.1
High school diploma	170	57.0
College degree	80	26.8
Graduate degree	24	8.1

Variable (type)	*n*	%
Having one or more comorbidities (independent)		
Yes	148	49.7
No	150	50.3

* The mean age was 13.89 ± 1.657 years.

Table 2 shows the frequency distribution of the independent variables in terms of access to health care. In the past year, the majority of participants (200, 67.1%) did not have a loss of insurance coverage when compared to those who did (94, 31.5%) who did.

Regarding medical bills, Table 2 shows that over half of the participants (58.4%) reported not having trouble paying them, whereas nearly 40% did report having trouble. For general health checkups, 155 children (52.0%) of participants visited a doctor often, while 143 children (47.9%) did not visit the doctor often or not at all. For physical health checkups, 151 children (50.7%) of participants visited the doctor often, while 146 children (49%) did not visit the doctor often or not at all. Additionally, as indicated in Table 2, most participants (60.1%) answered "no" to not getting medical care in the past 12 months because of cost, while the remaining participants answered "yes" to the question of not getting medical care because of money (see Table 2).

Table 2. *Frequency Distribution of the Independent Variables: Access to Health Care*

Variable (type)	*n*	%
Access to health care based on not having insurance coverage (independent)		
No	200	67.1
Yes	94	31.5
Missing	4	1.3
Access to health care based on having trouble paying medical bills (independent)		
No	174	58.4
Yes	115	38.6
Missing	9	3.0
Access to health care based on frequency of visiting a doctor for a general health checkup (independent)		
Often	155	52.0
Not often	139	46.6
Not at all	4	1.3
Missing	4	1.3
Access to health care based on frequency of visiting a doctor for a physical health checkup (independent)		
Often	151	50.7
Not often	142	47.7
Not at all	4	1.3
Missing	1	0.3
Access to health care based on not getting medical care because of cost (independent)		
No	179	60.1
Yes	115	38.6
Missing	4	1.3

The frequency distribution of the dependent and independent variables (i.e., age, race/ethnicity, daily diet, levels of income, children's parents' highest levels of education, and comorbidities), shown in Table 3, is based on the race/ethnicity of the children of the participants. The race/ethnicity distribution of the children of

participants who answered that their child did not have long COVID-19 syndrome was as follows: 13 were European American, five were African American, three were American Indian, and three were Hispanic. The frequency of the number of participants who answered that their child had long COVID-19 syndrome was 171 European American, 64 African American, 11 American Indian, three Alaska Native, three Asian, 21 Hispanic, and one of some other race. For the variable age, the age with the most participants was as follows: age 14 (n = 45) for European Americans, age 15 (n = 15) for African Americans, age 15 (n = 5) for American Indians, age 14 (n = 2) for Alaska Natives, age 11 (n = 2) for Asians, age 14 (n = 7) for Hispanics, and age 15 (n = 1) for those who are some other race.

For the variable daily consumption level of vegetables, the number of participants who answered that their children had below the daily recommendation was as follows: 155 were European American, 62 were African American, 12 were American Indian, three were Alaska Native, 23 were Hispanic, and one was of some other race. Regarding those who met the daily recommended level for vegetable consumption, six participants' children were African American, 29 were European American, one was American Indian, two were Asian, and one was Hispanic. For adolescents who were above the daily recommendation level for vegetable consumption, one participant's child was African American, one was American Indian, and one was Asian.

For the variable daily consumption level of fruit, the number of participants whose children were below the daily recommendation was as follows: 96 were European American, 47 were African American, 11 were American Indian, three were Alaska Native, 17 were Hispanic, and one was of some other race. Regarding adolescents who met the daily recommended level for fruit consumption, 19 participants' children were African American, 83 were European American, three were American Indian, three were Asian, and six were Hispanic. For adolescents who were above the daily recommendation level for fruit consumption, five participants' children were European American, three were African American, and one was Hispanic.

For the variable levels of income (socioeconomic status), most of the participants, based on race/ethnicity, had income levels of U.S. $39,401–$75,000, except for those who were American Indian ($75,001–$100,000). For the independent variable of having a comorbidity, the percentage of participants who answered that their children had a comorbidity based on race/ethnicity was as follows: 44% of European Americans, 55.5% of African Americans, 92.9% of American Indians, 100% of Alaska Natives, 100% of Asians, 45.8% of Hispanics, and 100% of some other race. The highest level of education for most parents was a high school diploma. European American parents (10.3%) had the most graduate degrees.

Table 3. *Frequency Distribution of the Dependent and Independent Variables (Age, Race/Ethnicity, Daily Diet, Levels of Income, Children's Parents' Highest Levels of Education, and Comorbidities) Based on the Race/Ethnicity of the Participants*

Variables	European American	African American	American Indian	Alaska Native	Asian	Hispanic	Some other race
Not having long COVID-19 syndrome	13 (7.1%)	5 (7.2%)	3 (21.4%)	0 (0%)	0 (0%)	3 (12.5%)	0 (0%)
Having long COVID-19 syndrome	171 (92.9%)	64 (92.8%)	11 (78.6%)	3 (100%)	3 (100%)	21 (87.5%)	1 (100%)
Age 11	11 (6.0%)	7 (10.1%)	3 (21.4%)	1 (33.3%)	2 (66.7.%)	1 (4.2%)	0 (0%)
Age 12	29 (15.8%)	10 (14.5%)	1 (7.1%)	0 (0%)	1 (33.3%)	2 (8.3%)	0 (0%)
Age 13	40 (21.7%)	12 (17.4%)	0 (0%)	0 (0%)	0 (0%)	2 (8.3%)	0 (0%)
Age 14	45 (24.5%)	10 (14.5%)	3 (21.4%)	2 (66.7%)	0 (0%)	7 (29.2%)	0 (0%)

Variables	European American	African American	American Indian	Alaska Native	Asian	Hispanic	Some other race
Age 15	30 (16.3%)	15 (21.7%)	5 (35.7%)	0 (0%)	0 (0%)	5 (20.8%)	1 (100%)
Age 16	20 (10.9%)	8 (11.6%)	1 (7.1%)	0 (0%)	0 (0%)	4 (16.7%)	0 (0%)
Age 17	9 (4.9%)	7 (10.1%)	1 (7.1%)	0 (0%)	0 (0%)	3 (12.5%)	0 (0%)
Below daily recommendation level of vegetables	155 (84.2%)	62 (90%)	12 (85.7%)	3 (100%)	0 (0%)	23 (95.8%)	1 (100%)
Meets daily recommendation level of vegetables	29 (15.8%)	6 (8.7%)	1 (7.1%)	0 (0%)	2 (66%)	1 (4.2%)	0 (0%)
Above daily recommendation level of vegetables	0 (0%)	1 (1.3%)	1 (7.1%)	0 (0%)	1 (33%)	0 (0%)	0 (0%)
Below daily recommendation level of fruit	96 (52.2%)	47 (68.1%)	11 (78.6%)	3 (100%)	0 (0%)	17 (70.8%)	1 (100%)
Meets daily recommendation level of fruit	83 (45.1%)	19 (27.5%)	3 (21.4%)	0 (0%)	3 (100%)	6 (25%)	0 (0%)
Above daily recommendation level of fruit	5 (2.7%)	3 (4.4%)	0 (0%)	0 (0%)	0 (0%)	1 (4.2%)	0 (0%)
$39,400 or less (lower class)	21 (11.4%)	14 (20.3%)	3 (21.4%)	0 (0%)	0 (0%)	6 (25%)	0 (0%)
$39,401–$75,000 (lower middle class)	97 (52.7%)	32 (46.4%)	3 (21.4%)	3 (100%)	1 (33%)	11 (45.8%)	1 (100%)
$75,001–$100,000 (middle class)	45 (24.5%)	16 (23.2%)	6 (42.9%)	0 (0%)	1 (33%)	6 (25%)	0 (0%)
$100,001 or more (upper middle class)	21 (11.4%)	7 (10.1%)	2 (11.3%)	0 (0%)	1 (33%)	1 (4.2%)	0 (0%)
Have comorbidity	81 (44.0%)	38 (55.5%)	13 (92.9%)	3 (100%)	3 (100%)	11 (45.8%)	1 (100%)
Do not have comorbidity	103 (66.0%)	31 (44.5%)	1 (8.1%)	0 (0%)	0 (0%)	13 (54.2%)	0 (0%)
Less than high school	5 (2.7%)	11 (15.9%)	3 (21.4%)	0 (0%)	0 (0%)	4 (16.7%)	1 (100%)
High school diploma	54 (29.3%)	11 14 (20.2%)	2 (14.3%)	1 (25%)	0 (0%)	9 (37.5%)	0 (0%)
College degree	106 (57.6%)	41 (59.4%)	9 (64.3%)	1 (25%)	2 (67%)	10 (41.7%)	0 (0%)
Graduate degree	19 (10.3%)	3 (4.3%)	0 (0%)	2 (50%)	1 (33%)	1 (4.2%)	0 (0%)

The frequency distribution of the independent variable access to health care, based on the race/ethnicity of the children of the participants, is shown in Table 4. For the independent variable access to health care, which

was based on not having insurance coverage, the percentage of participants based on the variable race/ethnicity who answered yes were as follows: 28.6% of European Americans, 36.8% of African Americans, 42.9% of American Indians, 0% of Alaska Natives, 66.7% of Asians, 34.8% of Hispanics, and 100% of some other race.

For the independent variable, having trouble paying the medical bills, the percentage of participants who answered that they had trouble paying medical bills, based on race/ethnicity, were as follows: 39.2% of European Americans, 44.8% of African Americans, 16.7% of American Indians, 100% of Alaska Natives, 33.3% of Asians, 39.1% of Hispanics, and 0% of some other race.

For the independent variable frequency of visiting the doctor for a general checkup, the percentage of participants who answered not often or not at all based on race/ethnicity were as follows: 45.1% of European Americans, 49.2% of African Americans, 57.1% of American Indians, 33.3% of Alaska Natives, 33.3% of Asians, 62.5% of Hispanics, and 100% of some other race.

For the independent variable frequency of visiting the doctor for a physical checkup, the percentage of participants who answered not often or not at all based on race/ethnicity was as follows: 42.4% of European Americans, 60.3% of African Americans, 35.7% of American Indians, 33.3% of Alaska Natives, 66.7% of Asians, 75% of Hispanics, and 100% of some other race.

For the independent variable access to health care based on not getting medical care because of cost, the percentage of participants who answered they did not get medical care because of cost based on race/ethnicity were as follows: 32.4% of European Americans, 52.9% of African Americans, 28.6% of American Indians, 33.3% of Alaska Natives, 33.3% of Asians, 60.9% of Hispanics, and 0% of some other race.

Table 4. *Frequency Distribution of the Independent Variable Access to Health Care Based on the Race/Ethnicity of the Participants*

Type of Variable	Variables	European American	African American	American Indian	Alaska Native	Asian	Hispanic	Some other race
Independent variable: access to health care based on not having insurance coverage	Yes	52 (28.6%)	25 (36.8%)	6 (42.9%)	0 (0%)	2 (66.7%)	8 (34.8%)	1 (100%)
	No	130 (71.4%)	43 (63.2%)	8 (57.1%)	3 (100%)	1 (33.3%)	15 (65.2%)	0 (0%)
Independent variable: access to health care based on having trouble paying medical bills	Yes	71 (39.2%)	30 (44.8%)	2 (16.7%)	2 (100%)	1 (33.3%)	9 (39.1%)	0 (0%)
	No	110 (60.8%)	37 (55.2%)	10 (83.3%)	0 (0%)	2 (66.7%)	14 (60.9%)	1 (100%)
Independent variable: access to health care	Often	101 (54.9%	35 (50.7%)	6 (42.9%)	2 (66.7%)	2 (66.7%)	9 (37.5%)	0 (0%)
	Not often	81 (44%)	34 (49.3%)	6 (42.9%)	1 (33.3%)	1 (33.3%)	15 (62.5%)	1 (100%)

based on the frequency of visiting a doctor for a general checkup	Not at all	2 (1.1%)	0 (0%)	2 (14.2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Percent that do not visit doctor often or not at all	45.1%	49.2%	57.1%	33.3%	33.3%	62.5%	100%
Independent variable: access to health care based on the frequency of visiting a doctor for a physical checkup	Often	106 (57.6%)	27 (39.7%)	9 (64.3%)	2 (66.7%)	1 (33.3%)	6 (25.0%)	0 (0%)
	Not often	75 (40.8%)	41 (60.3%)	4 (28.6%)	1 (33.3%)	2 (66.7%)	18 (75.0%)	1 (100%)
	Not at all	3 (1.6%)	0 (0%)	1 (7.1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Percent that do not visit doctor often or not at all	42.4%	60.3%	35.7%	33.3%	66.7%	75%	100%
Independent variable: access to health care based on not getting medical care because of cost	Yes	59 (32.4%)	36 (52.9%)	4 (28.6%)	1 (33.3%)	1 (33.3%)	14 (60.9%)	0 (0%)
	No	123 (67.6%)	32 (47.1%)	10 (71.4%)	2 (66.7%)	2 (66.7%)	9 (39.1%)	1 (100%)

Chi-Square Analysis Results

Table 5 shows the frequencies of having long COVID-19 syndrome based on seeing the doctor for a physical and general checkup, daily vegetable consumption, and daily fruit consumption. Table 6 shows the odds ratios for having long COVID-19 syndrome based on the frequency of visiting doctors for a physical checkup and daily intake of vegetables.

Based on the frequency of seeing the doctor for a physical checkup, the chi-square analysis results were $X^2(1,297) = 8.382$, $p = .004$. The odds of having long COVID-19 syndrome for those who visit the doctor often for a physical checkup, when compared to those who do not visit the doctor often for a physical checkup, were 0.25 ($p = .004$), while the odds of having long COVID-19 syndrome for those who do not visit the doctor often for a physical checkup, when compared to those who do visit the doctor often for a physical checkup, were 4.1 ($p = .004$).

Based on the frequency of daily consumption of vegetables with the frequency of having long COVID-19 syndrome, the chi-square analysis was $X^2(2,298) = 14.389$, $p < .001$. The odds ratio of having long COVID-19 syndrome for those whose daily consumption of vegetables is above the daily recommendation when compared to those who are below the daily recommendation was 0.04 ($p < .001$), while the odds ratio of having long COVID-19 syndrome for those whose daily consumption of vegetables is below the daily recommendation, when compared to those who are above the daily recommendation was 23.6.

Table 5. *Crosstabs Table for the Frequencies of Having Long COVID-19 Syndrome Based on Seeing the Doctor for Physical and General Checkups, Daily Vegetable Consumption, and Daily Fruit Consumption*

		Have long COVID-19 syndrome	
Independent variable	*n*	No	Yes
Frequency of seeing a doctor for a physical checkup			
Often	151	19	132
Not often	146	5	141
Frequency of visiting a doctor for general checkup			
Often	155	15	140
Not often	143	9	134
Frequency of daily consumption level of vegetables			
Daily recommendation	39	2	37
Below daily recommendation	256	20	236
Above daily recommendation	3	2	1
Frequency of daily consumption level of fruit			
Daily recommendation	114	6	108
Below daily recommendation	175	17	158
Above daily recommendation	9	1	8

Table 6. *Odds Ratios for Having Long COVID-19 Syndrome Based on the Frequency of Visiting Doctors for Physical Checkups and Daily Intake of Vegetables*

Description	*OR*
Visiting the doctor often for a physical checkup compared to those who do not visit the doctor often for a physical checkup	0.25
Visiting the doctor not often for a physical checkup compared to those who visit the doctor often for a physical checkup	4.1
Daily consumption of vegetables is above the daily recommendation when compared to those who meet the daily recommendation	0.03
Daily consumption of vegetables meets the daily recommendation when compared to above the daily recommendation	37
Daily consumption of vegetables is above the daily recommendation when compared to below the daily recommendation	0.04
Daily consumption of vegetables is below the daily recommendation when compared to above the daily recommendation	23.6

Bivariate Logistic Regression Results

The logistic regression results for predicting the odds of having long COVID-19 syndrome for each of the independent variables is shown in Table 7. The logistic regression results determined that the odds ratio of having long COVID-19 syndrome for those whose daily consumption level was above the daily recommendation when compared to those whose daily consumption level met the daily recommendations was 0.027 (p = .011).

The odds ratio of having long COVID-19 syndrome for those whose income was $39,401–$75,000 when compared to those whose income was $75,001–$100,000 was 6.286 (p = .002). The odds ratio of having long COVID-19 syndrome for those who did not have health insurance coverage when compared to those who do was 3.359 (p = .044). The odds ratio of having long COVID-19 syndrome for those who did not have money to pay medical bills when compared to those who did was 8.178 (p = .005). The odds ratio of having long COVID-19 syndrome for those who did not visit the doctor because of cost when compared to those who did

was 7.917 (p = .006). The odds ratio of having long COVID-19 syndrome for those whose parents' highest level of education was a graduate degree when compared to those whose family's highest level of education was a high school diploma was 0.095 (p = .001).

Table 7. *Logistic Regression Results for Predicting the Odds of Having Long COVID-19 Syndrome for Each of the Independent Variables*

Independent variable	B	*SE*	*Wald*	*df*	*Sig*	exp(B)	95% CI for exp(B)	
							Lower	Upper
Age	-0.144	.130	1.231	1	.267	.866	.671	1.117
Race/ethnicity (European American, as reference)								
African American	-.027	.546	.002	1	.960	.973	.334	2.839
American Indian	-1.277	.712	3.219	1	.073	.279	.069	1.125
Alaska Native	18.626	23205.42	.000	1	.999	1.2E8	0	
Asian	18.626	23205.42	.000	1	.999	1.2E8	0	
Hispanic	-.631	.681	.858	1	.354	.532	.140	2.022
Some other race	18.626	40192.96	.000	1	1.000	1.2E8	0	
Daily consumption of vegetables (meets the requirements as reference)								
Below daily recommendation	-.450	.762	.348	1	.555	.638	.143	2.842
Above daily recommendation	-3.611	1.424	6.432	1	.011	.027	.002	.440
Daily consumption of fruits (meets the requirements-reference)								
Below daily recommendation	-.661	.491	1.812	1	.178	.516	.197	1.352
Above daily recommendation	-.811	1.141	.505	1	.477	.444	.048	4.156
Levels of income ($75,000–$100,000, as reference)								
$39,400 or less	.557	.618	.814	1	.367	1.746	.520	5.861
$39,401–$75,000	1.838	.603	9.291	1	.002	6.286	1.928	20.498
$100,001 or more	-.059	.586	.010	1	.920	.943	.299	2.975
Parents' highest level of education (college degree, as reference)								
High school diploma	-.847	.944	.805	1	.370	.429	.067	2.728
Less than high school	-.668	.660	1.022	1	.312	.513	.141	1.871
Graduate degree	-2.358	.740	10.145	1	.001	.095	.022	.404
Access to health care based on not having insurance coverage (no, as reference)								
Yes	1.269	.630	4.053	1	.044	3.559	1.034	12.245
Access to health care, based on not having money to pay medical bills (no, as reference)								
Yes	2.101	.749	7.873	1	.005	8.178	1.884	35.490
Access to health care, based on not visiting doctor because of the cost (no, as reference)								
Yes	2.069	.749	7.635	1	.006	7.917	1.825	34.351
Comorbidity (no, does not have a comorbidity as reference)								
Yes (has a comorbidity)	-.167	.427	.153	1	.696	.846	.366	1.954

Note. CI = confidence interval.

Discussion

Chi-square analysis found that the frequency of visiting the doctor for a physical checkup (p = .004) and the frequency of daily consumption level of vegetables (p < .001) were significant factors for predicting the risk of long COVID-19 for adolescent children (Table 5). The frequency of daily consumption of fruit and the frequency of visiting the doctor for a general checkup were not significant factors for predicting the risks of long COVID-19 (Table 5). The chi-square analysis found that visiting the doctor often for a physical checkup had lower odds of having long COVID-19 syndrome when compared to those who do not (0.25 versus 4.1, Table 6). The odds ratio for having long COVID-19 syndrome for those whose daily consumption level of vegetables is more than the daily recommendation is lower than for those whose daily consumption level is below the daily recommendation (0.03 versus 23.6; Table 6).

The logistic regression results (Table 7) revealed that age, race/ethnicity, daily consumption level of fruits, and having a comorbidity were not a significant association with predicting the risks of having long COVID-19 syndrome. The independent variable, daily consumption level of vegetables, had a significant association with predicting the odds of having long COVID-19 for those whose daily vegetable consumption was above the daily recommendations (2–3 cups). The independent variable levels of income had a significant association with predicting the odds of having long COVID-19 syndrome for those whose income was $39,401–$75,000 (p = .002). The independent variable, having health insurance coverage, had a significant association with predicting the odds of having long COVID-19 syndrome for those who did not have health insurance coverage. The independent variable, not having money to pay medical bills, had a significant association with predicting the odds of having long COVID-19 syndrome for those who did not have money to pay medical bills. The independent variable, not visiting the doctor because of cost, had a significant association with predicting the odds of having long COVID-19 syndrome for those who did not visit the doctor because of cost. The independent variable, parents' highest level of education, had a significant association with predicting the odds of having long COVID-19 for parents whose highest level of education was a graduate degree (p = .001).

Interpretation

The results of the study found that children whose daily consumption level of vegetables was more than the daily recommendation had lower odds of having long COVID-19 syndrome when compared to children whose daily consumption level was below the daily recommendation (p = .011, OR = 0.027, 95% CI [.002, .440]). These results support previous research that found that preventing the dysregulation of the immune system is essential to preventing COVID-19 morbidity (Ni et al., 2020; Shirbhate et al., 2021).

Dysregulation of the immune system is due to the overproduction of cytokine factors, which can contribute to cytokine storms that can lead to morbidity and possible death (Hojyo et al., 2020). The prevention of immune dysregulation is one possible explanation for why some infected adolescents with COVID-19 develop long COVID-19 syndrome (Aghili et al., 2021; Hojyo et al., 2020). Higher consumption levels of vegetables may be a contributing factor in preventing dysregulation of the immune system by decreasing the overexpression of factors like cytokines, leucocytes, and inflammatory biomarkers (Buonsenso et al., 2022; Hojyo et al., 2020; Zhang et al., 2021). The overexpression of these factors is one possible explanation as to why some children may be more at risk for long COVID-19 syndrome based on their daily consumption of vegetables (Buonsenso et al., 2022; Hojyo et al., 2020; Zhang et al., 2021).

African Americans have the highest mortality rate due to COVID-19 infection when compared to other racial/ethnic groups in the United States (Abedi et al., 2021; Lopez et al., 2021; Phillips et al., 2021). This study found no significant association with the risks of having long COVID-19 syndrome for African American, Hispanic, American Indian, Alaska Native, and Asian adolescents when compared to European American adolescents. However, the study did find that over 50% of the parents of African American

adolescents indicated that their children did not get medical care because of cost (52.9%) and that they do not visit the doctor often for a physical checkup (60.3%).

The study further found that 60.9% of the parents of Hispanic adolescents reported that they did not get medical care because of cost, and 75% did not visit the doctor often for a physical checkup. And the percentage of European American adolescents whose parents reported that they did not get medical care because of cost was 32.4%, and 42.4% of the parents of European American adolescents reported that they did not visit doctors often for physical checkups.

The data provided a snapshot of the current health disparities that exist for African American and Hispanic adolescents based on social determinants of health (Kalyanaraman, 2020; Kopel et al., 2020; Zakeri et al., 2020). These social determinants of health are due to a family's ability to afford and get medical care for preventive health (Kalyanaraman, 2020; Kopel et al., 2020; Zakeri et al., 2020).

Impact of Comorbidity on the Immune System

Previous research found that having comorbidities may be a contributing factor for having immune dysregulation, which can lead to severe morbidity for those who have COVID-19 infection (Aghili et al., 2021; Qian et al., 2021). This severe morbidity is a possible risk factor for having long COVID-19 syndrome (Aghili et al., 2021; Osmanov et al., 2022). Our study found that having comorbidities was not a significant factor for predicting the odds of having long COVID-19 syndrome for children aged 11–17 years (p = .696). These results support the research findings by Chao et al. (2020), which found that comorbidities like obesity and asthma were not significant risk factors for having severe COVID-19 morbidity for children under the age of 10. The results of this study contradicted research by Zhang et al. (2023) and Aghili et al. (2021), which found that comorbidity was a main risk factor for severe COVID-19 morbidity (Aghili et al., 2021; Zhang et al., 2023). However, both studies did find that unhealthy diets may play a factor in predicting the risks of having severe COVID-19 morbidity.

Impact of Age on Risk of Long COVID-19 Syndrome

In this study, age was not a significant factor in predicting the risks of having long COVID-19 syndrome (p = .267). The parent participants' children ranged from age 11–17 with an average age of 14. Most (91.9%) of those participants reported that their children had long COVID-19 syndrome, as opposed to 8.1% reporting that their children did not have long COVID-19 syndrome. The results of this study supported previous studies by Dumont et al. (2022), Miller et al. (2021), Lopez-Leon et al. (2022), and Osmanov et al. (2022), which found that being between the ages of 12 and 18 is a risk factor for having long COVID-19 syndrome. Even though age was not a significant predictor of long COVID-19, the data showed that a high percentage of adolescents had experienced long COVID-19 syndrome.

Impact of Income and Family Education Levels on the Risks of Long COVID-19 Syndrome

Children of the participants in this study whose families were lower middle class had an increased risk (OR = 6.286, 95% CI [1.928, 20.498]) of having long COVID-19 syndrome. A significant association existed for not having long COVID-19 syndrome for parents whose highest level of education was a graduate degree (p = .001, OR = 0.095, 95% CI [.022, .404]. The results of the study concurred with those of a previous study by Dumont et al. (2022), which found that having low socioeconomic status (level of income) is a significant risk factor for having long COVID-19 syndrome.

One possible explanation for these results is based on the factor of having money to pay for health care (Litton & Beavers, 2021). Families whose income is below the middle class may have less access to health care (Baumer et al., 2020; David et al., 2022). Parents' highest level of education can also affect the decisions that families make as to the frequency of visits to doctors, as well as the type of food consumed by the family (Baumer et al., 2020; David et al., 2022).

Impact of Access to Health Care on the Risks of Long COVID-19 Syndrome

The study found that having access to health care had a significant association with the risks of having long COVID-19 syndrome. The variables of not having insurance coverage in the past 12 months (*OR* = 5.686, 95% CI [1.160, 27.870]), not having money to pay medical bills (*OR* = 9.627, 95% CI [1.938, 47.835]), not visiting the doctor often for a physical checkup (*OR* = 4.1), and not visiting the doctor because of cost (*OR* = 15.0, 95% CI [1.758, 127.951]) had increased odds of having long COVID-19 syndrome. These results supported our review of articles that found that social determinant factors like access to health care are an important factor that could be contributing to the current health disparities due to the COVID-19 pandemic (David et al., 2022).

One explanation for these health disparities is that adolescents whose families do not have access to health care may be experiencing the effects of stress and neighborhood adversity, which may be contributing to their risks of having long COVID-19 syndrome (Baumer et al., 2020; Kalyanaraman, 2020). The results of this study provided support to the conclusions that social determinants of health had a large impact on adolescents' risks of having long COVID-19 syndrome (Baumer et al., 2020; Federico et al., 2020).

Impact of Daily Diet on the Risks of Long COVID-19 Syndrome

The study found that adolescents whose daily vegetable consumption is more than the daily recommendation (2–3 cups per day) had a lower odds ratio of having long COVID-19 when compared to adolescents whose daily vegetable consumption is below the daily recommendation (0.03 versus 23.6). The study found that there was no association with the daily consumption level of fruits and the risks of having long COVID-19 (p = .375).

One explanation for these results is the presence of flavonoids, which are present in vegetables and some fruits (Al-Khayri et al., 2022; Zhu et al., 2018). Vegetables have been found to contain more nutrients than fruits, which may have more of an effect on the immune system (Al-Khayri et al., 2022; U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2020; Zhu et al., 2018).

Another explanation for this difference is the possibility that the children whose daily consumption level of vegetables was above the daily recommendation had consumed vegetables that were high in flavonoids (Al-Khayri et al., 2022). These vegetables with high levels of flavonoids may have helped prevent these children from developing long COVID-19 syndrome (Al-Khayri et al., 2022). The lack of a correlation between the daily consumption level of fruit with the risks of long COVID-19 syndrome suggests that other factors like physical activity may affect adolescents' risks of having long COVID-19 syndrome (Shao et al., 2021).

Limitations

The first limitation of the research study was that it was only able to determine the level of association with the risk factors of daily diet and ethnicity and the risks of long-term COVID-19 symptoms (Behnood et al., 2022). The research was not able to determine whether any of these risk factors are causative for making children have long COVID-19 syndrome (Behnood et al., 2022). The study was confined to only one geographic location, which may limit the ability to generalize to other research settings (Zakeri et al., 2020). However, the study did represent an area of the United States that was the epicenter of the COVID-19 pandemic in 2020 (Thompson et al., 2020).

Implications for Public Health Theory and Practice

The impact of having access to health care, parents' highest level of education, daily consumption level of vegetables, and levels of income on the risk of having long COVID-19 syndrome may be understood by the constructs of the health belief model (Baumer et al., 2020; Rosenstock, 1974). For the construct of perceived susceptibility, the variables levels of income, family level of education, and daily consumption level of

vegetables can affect the approaches that adolescents take regarding taking action to reduce the risk of long-term COVID-19 syndrome (Rosenstock, 1974; Szabó & Pikó, 2019). The variable levels of income and education could affect adolescents' perceptions of how susceptible they are to having long COVID-19 syndrome, which could affect their actions in terms of what types of food they choose to consume (Rosenstock, 1974).

The construct of perceived severity could affect parents' perceptions of their children's risks of getting long COVID-19 syndrome, which could in turn influence their decisions on how many servings of vegetables they chose to feed their children daily (Rosenstock, 1974). For the construct of perceived benefits, the variables of daily consumption level of vegetables and access to health care could explain adolescents' risks of having long COVID-19 syndrome (Rosenstock, 1974). The decisions that adolescents make regarding how many servings of vegetables they consume may be affected by their perception of the benefits of eating vegetables (Rosenstock, 1974).

Having access to health care may be affected by the factors of whether the family has insurance coverage or money to pay medical bills and how often adolescents visit the doctor for a physical checkup. These factors may be affected by the family's perception of what benefit they will receive from visiting the doctor for medical care (Rosenstock, 1974).

For the construct of perceived barriers, the variables levels of income and access to health care can explain adolescents' risks of having long COVID-19 syndrome (Rosenstock, 1974). Having an income that is below the middle class may be seen as a possible barrier for parents in terms of taking action to protect themselves and their children from having long COVID-19 syndrome (Rosenstock, 1974). This barrier may affect their decisions as to what types of food they encourage their children to consume (Rosenstock, 1974). Not having access to health care may also be seen by adolescents and their parents as a perceived barrier to taking action to eat healthy and protect themselves from having long COVID-19 syndrome (Rosenstock, 1974).

For the construct of cue to action, the variable of having access to health care and parents' level of education may affect an adolescent's risk of having long COVID-19 syndrome (Rosenstock, 1974). Having access to health care and a parent's level of education may provide adolescents with important health-care information about what actions they and their parents need to take to reduce their risks of having long COVID-19 syndrome (Rosenstock, 1974). For the construct of self-efficacy, the variables of having access to health care and daily consumption levels of vegetables may affect adolescents' risks of having long COVID-19 syndrome (Rosenstock, 1974). It is adolescents' and parents' personal beliefs in terms of what foods they should consume that will determine their daily consumption level of vegetables (Rosenstock, 1974). Having access to health care will also affect adolescents' and their parents' personal beliefs in terms of what actions they believe need to be taken to reduce their risks of having long COVID-19 syndrome (Rosenstock, 1974). The health belief model helped explain the variables that were found to be significant in their association with the risk of long COVID-19 syndrome.

Additional research needs to be performed to investigate the effect of daily diet in combination with physical activity on the risks of having long COVID-19 syndrome (Shao et al., 2021). The COVID-19 pandemic has contributed to food insecurity and a lack of physical exercise for adolescent children (Cerasola et al., 2022). Previous research has found that physically active people have fewer hospitalizations and fewer respiratory illnesses (Gomide et al., 2022). Research needs to be performed to determine whether increasing physical activity in combination with a diet high in vegetables will help reduce adolescent children's risk of having long COVID-19 syndrome (Detopoulou et al., 2021). The results of this research study did find that those who had consumed far more than the daily recommendations for vegetable consumption had lower odds of having long COVID-19 syndrome than those who just met the daily recommendations. However, the study did not collect data on the types of vegetables adolescents consumed and whether those types of vegetables affected the odds

of adolescent children having long COVID-19 syndrome. Additional research is recommended to determine what types of vegetables may affect the odds of having long COVID-19 syndrome (Detopoulou et al., 2021).

The study found that adolescents whose families' socioeconomic status was lower middle class had a significantly higher risk of having long COVID-19 syndrome (*OR* = 6.286 (95% CI [1.928, 20.498]). Families whose highest level of education was a graduate degree had a lower risk of long COVID-19 syndrome for adolescent children (p = .001, *OR* = 0.095, 95% CI [.022, .404]). Those who did not have access to health care also had a significantly higher risk of having long COVID-19 syndrome (not having insurance coverage, having trouble paying medical bills, or not getting medical care because of cost). These results provided important information about how social determinants of health may be a contributing factor to the current health disparities due to the COVID-19 pandemic (Zakeri et al., 2020). One recommendation for practice would be to use the factor of access to health care and socioeconomic status when designing interventions to help reduce children's risks of long COVID-19 syndrome and reduce the current health disparities (Zakeri et al., 2020). Families that are lower middle class need additional assistance to have improved access to health care and education (Kopel et al., 2020; Zakeri et al., 2020).

The current study also found that children who visit a doctor less often for a physical checkup had a higher risk of having long COVID-19 syndrome than those who visit a doctor often for a physical checkup. This information highlighted the importance of going to the doctor for preventative health to reduce the chance of having long COVID-19 syndrome (Suarez-Lopez et al., 2021). Health knowledge interventions need to be created to teach families of adolescents the importance of having their children go to the doctor for a physical checkup (Suarez-Lopez et al., 2021). These interventions need to use the health belief model in the intervention design to address the adolescent's family's perceived benefits, perceived vulnerability, cues to action, perceived barriers, perceived susceptibility, and self-efficacy (Rosenstock, 1974). These health constructs need to be addressed in any health interventions for reducing adolescents' risks of having long COVID-19 syndrome (Rosenstock, 1974).

Conclusion

This study found that adolescents whose daily vegetable consumption was more than the daily recommendation had a lower odds ratio of having long COVID-19 syndrome (*OR* = 0.03) when compared to adolescents whose daily vegetable consumption was below the daily recommendation (2–3 cups; *OR* = 23.6). The study did not find an association with the daily consumption level of fruits and the risks of having long COVID-19 syndrome (p = .375). There was no significant association with the risk of having long COVID-19 syndrome for African American, Hispanic, American Indian, Alaska Native, and Asian adolescents when compared to European American adolescents. However, my research did find that over 50% of the participants whose children were African American reported not getting medical care because of money (52.9%) and not visiting the doctor often for a physical checkup (60.3%). We found that 60.9% of the participants whose children were Hispanic reported not getting medical care because of money, and 75% reported not visiting the doctor often for a physical checkup.

Having comorbidities and age were not significant factors for predicting the odds of having long COVID-19 syndrome for children aged 11–17 years. The children of families that were lower middle class had an increased risk (*OR* = 6.286, 95% CI [1.928, 20.498]) of having long COVID-19 syndrome, while parents with a graduate degree contributed to a lower risk (*OR* = 0.095, 95% CI [.022, .404]) of having long COVID-19. The study found that having access to health care had a significant association with the risks of having long COVID-19 syndrome. The following variables had increased odds of having long COVID-19 syndrome: not having insurance coverage in the past 12 months (*OR* = 5.686, 95% CI [1.160, 27.870]), not having money to pay medical bills (*OR* = 9.627, 95% CI [1.938, 47.835]), not visiting a doctor often for a physical checkup (*OR*

= 4.1), and not visiting a doctor because of cost (*OR* = 15.0, 95% CI [1.758, 127.951]). The daily consumption level of vegetables, access to health care, parents' level of education, and levels of income (socioeconomic status) had a significant association with predicting the risks of long COVID-19 syndrome for adolescents aged 11–17 years. Improving access to health care for those who are lower middle class and increasing adolescents' daily consumption of vegetables are important risk factors for reducing adolescents' odds of having long COVID-19 syndrome.

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