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Original article

Medical Vulnerability of Young Adults to Severe COVID-19 Illness—Data From the National Health Interview Survey

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ABSTRACT

Purpose: COVID-19 morbidity and mortality reports in the U.S. have not included findings specific to young adults. The Centers for Disease Control and Prevention provides a list of conditions and associated behaviors, including smoking, conferring risk of severe COVID-19 illness regardless of age. This study examines young adults' medical vulnerability to severe COVID-19 illness, focusing on smoking-related behavior.

Methods: A young adult subsample (aged 18–25 years) was developed from the National Health Interview Survey, a nationally representative data set, pooling years 2016–2108. The medical vulnerability measure (yes vs. no) was developed, guided by the Centers for Disease Control and Prevention risk indicators. The estimates of medical vulnerability were developed for the full sample, the nonsmoking sample, and the individual risk indicators. Logistic regressions were conducted to examine differences by sex, race/ethnicity, income, and insurance.

Results: Medical vulnerability was 32% for the full sample and half that (16%) for the nonsmoking sample. Patterns and significance of some subgroup differences differed between the full and the nonsmoking sample. Male vulnerability was (33%) higher than female (30%; 95% CI: .7–.9) in the full sample, but lower in nonsmokers: male (14%) versus female (19%; 95% CI: 1.2–1.7). The white subgroup had higher vulnerability than Hispanic and Asian subgroups in both samples—full sample: white (31%) versus Hispanic (24%; 95% CI: .6–.9) and Asian (18%; 95% CI: .4–.5); nonsmokers: white (17%) versus Hispanic (13%; 95% CI: .06–.9) and Asian (10%; 95% CI: .3–.8).

Conclusions: Notably, lower young adult medical vulnerability within nonsmokers versus the full sample underscores the importance of smoking prevention and mitigation.

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IMPLICATIONS AND CONTRIBUTION

Close to one third of young adults are medically vulnerable to severe COVID-19 illness. Smoking is the strongest risk factor for young adults with one in 10 participating in past 30-day smoking.

This manuscript has been approved by all authors, is not under review at any other journal, and if accepted, will not be published in any other venue.

Conflicts of interest: The authors confirm that they have no conflicts of interest.

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As the COVID-19 pandemic unfolds in the U.S., assessing the risk of severe illness across populations can help guide public health responses. Research to date has identified several populations with higher rates of COVID-19 mortality and morbidity, such as people of ages 65 or older and racial/ethnic minorities [1–4]. In addition, the Centers for Disease Control and

Prevention (CDC) has identified medical conditions that put individuals of any age at risk of severe illness due to infection with the COVID-19 virus, severity defined as may be more likely to need hospitalization or intensive care or to die of the infection. Among these are diabetes; heart disease; immune problems due to immune deficiencies, including medical treatments, medications, smoking, or poorly controlled HIV or AIDS; and chronic lung disease/asthma [5].

As the media report on vulnerability to COVID-19 and examine attitudes toward risk among U.S. populations, some reporting suggests that young adults consider themselves invulnerable to the virus [6,7]. However, survey data indicate that they are as worried or nearly as worried about contracting the virus as older adults [8]. Furthermore, they are more likely than older adults to be concerned about unknowingly spreading the virus, with an April Kaiser Family Foundation poll indicating 95% of 18- to 24-year-olds are exercising social distancing [8,9].

Young adults, generally defined as those in their late teen years to the mid- to late- 20s, are a unique population. They have similar health issues as adolescents but face greater barriers to health care as they transition to adult roles and responsibilities [10–12]. Young adults differ from older adults in access to and utilization of health care services [11]. However, young adults are often grouped in with older adults in health and health care reports, despite these key differences in health issues and health care [11]. This has also occurred in reporting on the COVID-19 pandemic. In late March, the CDC reported on COVID-19 morbidity in the U.S. by age, including the age group 20–44 years, which some media reporting labeled as “younger adults” [13,14]. At the time, the 20- to 44-year-old group comprised 20% of patients hospitalized with COVID-19 and 12% of those admitted to intensive care units [15].

A newer CDC report uses more specific age groups, presenting COVID-19 mortality data for ages 15–24 years, an age group with fairly similar health issues [16]. However, we are not aware of any analyses specific to young adults that assesses the risk of severe COVID-19 or prevalence of COVID-19 morbidity. Such analyses may help inform public health responses that integrate the distinct needs and risks of young adults.

Recent evidence indicates that smoking is associated with a higher likelihood of COVID-19 disease progression, including increased illness severity, intensive care unit admission, or death [17], primarily because of its damage to upper airways and decreases in pulmonary immune function [18]. This smoking factor is of importance for young adults, who typically have low rates for most chronic illnesses [19] but relatively higher smoking rates [20,21]. Furthermore, recent research has indicated that young adults are initiating first-time smoking at higher rates than adolescents, a reversal of previous initiation patterns [22].

The present analysis aims to begin addressing the gap in knowledge about young adults and severe COVID-19 illness by examining the extent to which young adults are medically vulnerable to severe COVID-19 illness. The study uses data from the National Health Interview Survey (NHIS), a nationally representative data set, and draws on the CDC’s list of medical conditions and associated factors that confer vulnerability to severe COVID-19 illness. Specifically, our study had three aims: (1) to estimate the percentage of young adults medically at risk for severe COVID-19 illness and subgroup differences, based on the CDC’s criteria; (2) to estimate the percentage of nonsmoking young adults medically vulnerable to severe COVID-19 illness and subgroup differences; and (3) to estimate percentages of the

individual vulnerability indicators comprising the composite measure and subgroup differences.

Methods

Study design and sampling

The NHIS is an annual cross-sectional household interview survey of the U.S. civilian noninstitutionalized population sponsored by the National Center for Health Statistics. The NHIS consists of a set of core components (largely unchanged across years) and supplemental components. The four core components are Household Composition, Family Core, Sample Child Core (one child from each family if there is a child), and the Sample Adult Core (one adult aged 18 years or older from each family). Together, these collect information including socio-demographic characteristics, health status and behavior indicators, activity limitations, injuries, health insurance coverage, and access to and utilization of health care services. Data are weighted to allow the establishment of national population estimates. The study protocol was approved by the Committee on Human Research at the University of California, San Francisco under the exempt status.

Participants

The current analysis uses the most recent NHIS data available from the Sample Adult Core, Family Core, and Imputed Income files, pooled over 3 years (2016–2018) to derive a young adult subsample aged 18–25 years. The pooled young adult analytic sample includes a total of 8,405 participants—3,510 (2016); 2,716 (2017); and 2,179 (2018).

Study objectives

Objective 1. The first objective was to determine the overall estimates of young adults who have medical vulnerability to severe COVID-19 illness (yes vs. no), using a composite measure of health conditions and smoking practices and its subgroup differences (i.e., sex, race/ethnicity, income, and insurance status).

Objective 2. The second objective was to determine the estimate of nonsmoking young adults who have medical vulnerability to severe COVID-19 illness and its subgroup differences.

Objective 3. The third objective was to determine the estimates of the individual medical vulnerability indicators including conditions and smoking indicators and their subgroup differences.

Study variables

Outcome variables

Overall medical vulnerability to severe COVID-19 illness. To develop an overall indicator of “medical vulnerability” for severe COVID-19 illness, we selected nine indicators of medical conditions or smoking behaviors available in the sample adult data set: eight that have been identified by the CDC and one smoking behavior, e-cigarette use, which has been identified as contributory to respiratory and immune illness [5,23]. Overall medical

vulnerability was coded as yes versus no. In this study, to examine young adults' medical vulnerability to severe COVID-19 illness, we elected to use an overall medical vulnerability estimate for the outcome variable, rather than a cumulative score of indicators. The CDC list that guided the development of the outcome variable did not include information about which of the risk indicators, if any, confer greater risk of severe COVID-19 illness. Without data on the relative impact of individual indicators on overall vulnerability, a cumulative indicator has limited reliability.

The six medical condition indicators were as follows: ever told by a doctor you had a (1) heart condition (coronary heart disease, angina, and heart attack); (2) diabetes; (3) asthma (then further queried to gain an estimate of current asthma, used as the asthma indicator in this analysis); (4) immune condition (some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia); (5) told in the past 12 months you had any kind of liver condition; and (6) obesity (body mass index ≥ 40 kg/m²). Three smoking-related (referred to as smoking) indicators related to immune and respiratory function were past 30-day use of (7) tobacco; (8) electronic cigarettes (e-cigarettes—not included in CDC indicator list); and (9) cigar or cigar-type products. E-cigarette use was included as a smoking-related risk factor because of its adverse effects on respiratory and immune function and in response to suggestion by the National Institute on Drug Abuse that COVID-19 disease could be a serious threat to those who smoke tobacco, marijuana, or vape [23,24].

Subgroup and covariate variables. Sex, race, ethnicity, income (imputed), and insurance status were available in NHIS data sets. Race and ethnicity were recoded into a race/ethnicity subgroup variable, including non-Hispanic white (referred to as white), non-Hispanic black (referred to as black), Hispanic, non-Hispanic Asian (referred to as Asian), and non-Hispanic other (included American Indian Alaskan Native, multiple races, and race group not releasable and referred to as other). Income was recoded into Federal Poverty Level (FPL) categories: (1) <100% FPL; (2) 100% to <200% FPL; (3) 200% to <400% FPL; and (4) $\geq 400\%$ FPL. The NHIS provides imputation of income to account for a significant level of nonresponse on income measures. Insurance was recoded into full-year insured, partial-year uninsured, and full-year uninsured. Year of survey administration is included as a covariate but is not included as a subgroup in the tables.

Analysis plan

All analyses were conducted using variables including population weights to derive estimates representative of the national population and those to account for the complex survey design. To account for the large size of the full sample, we have selected $p < .01$ as the maximum level of reporting for significant findings. We developed the estimates of (1) overall medical vulnerability outcome (yes vs. no) and associated subgroup breakdowns; (2) medical vulnerability (yes vs. no) among the nonsmoking population and associated subgroup breakdowns; and (3) the nine individual condition and smoking medical vulnerability indicators. Individual indicators were determined for the full young adult sample and by subgroup categories: sex, race/ethnicity, income, and insurance. The estimates for some of the condition indicators were very low in the young adult sample. Thus, when determined by subgroups, many had insufficient sample sizes to yield reliable estimates. Estimates with a relative

standard error above 25% are noted in Tables 3 and 4 in italics to indicate statistical unreliability/instability.

Logistic regressions were conducted to compare subgroup differences (sex, race/ethnicity, income, and insurance status) within (1) overall medical vulnerability; (2) medical vulnerability for nonsmokers; and (3) individual vulnerability indicators. For the overall medical vulnerability and vulnerability among nonsmoker outcomes, the results include differences (p values and 95% confidence intervals) derived from adjusted odds ratios, adjusting for sex, race/ethnicity, income, insurance status, and year of survey administration. Logistic regression to determine subgroup differences within individual vulnerability indicators, which often include estimates with small N s, was based on unadjusted odds ratios. Because many subcategory estimates were statistically unreliable, we reported regression results of subgroup differences only if the referent subcategory estimate was stable and only for subcategories with stable estimates.

Results

The young adult sample consisted of approximately half females and half males. Fifty-five percent were white, 13% black, 22% Hispanic, 6% Asian, and 4% other. FPL subgroups were 23% in <100%, 20% in 100% to <200%, 31% in 200% to <400%, and 26% in $\geq 400\%$. Eighty-two percent had full-year insurance, 10% were partial-year uninsured, and 8% were full-year uninsured (Table 1).

Objective 1

Overall medical vulnerability for the full sample was 32% (Table 2). Males were more likely to be vulnerable (33%) than females (30%), $p < .01$. Significant differences were noted by race/ethnicity. The white subgroup vulnerability (35%) was significantly greater than the black (31%; $p < .01$), the Hispanic (24%; $p < .001$), and the Asian subgroups (18%; $p < .001$). Within income groups, compared with the highest income group $\geq 400\%$ FPL (27%), vulnerability rates were significantly higher in the lower income groups: <100% FPL (35%) and 100% to <200% FPL (36%),

Table 1
Young adult analytic sample demographics, ages 18–25 years, NHIS 2016–2018

Demographic subgroups	Young adult sample (N = 8,405), weighted % (N)
Sex	
Male	50.4 (4,085)
Female	49.6 (4,320)
Race/ethnicity	
NH white	55.0 (5,006)
NH black	13.3 (958)
Hispanic	22.1 (1,514)
NH Asian	5.5 (555)
NH Other	4.1 (372)
Income category (%FPL)	
<100%	23.0 (2,842)
100–<200%	20.2 (1,748)
200–<400%	30.5 (2,211)
$\geq 400\%$	26.4 (1,603)
Insurance status	
Full-year insured	82.0 (6,777)
Partial-year uninsured	9.7 (815)
Full-year uninsured	8.2 (578)

NH = non-Hispanic; NHIS = National Health Interview Survey.

Table 2

Young adult COVID-19 medical vulnerability: full sample and within nonsmoking population rates and differences, ages 18–25 years, NHIS 2016–2018

	COVID-19 medical vulnerability: full YA sample (N = 8,405)	COVID-19 medical vulnerability: YA nonsmoking subsample (N = 6,741)
	% Vulnerable (N) (95% CI)	% Vulnerable (N) (95% CI)
Analytic samples	31.5 (2,765)	16.1 (1,101)
Sex		
Female	29.7 (1,346) (.7–.9) ^{*a}	18.6 (705) (1.2–1.7) ^{**}
Male ^{Ref}	33.3 (1,419)	13.4 (396)
Race/ethnicity		
NH white ^{Ref}	35.4 (1,800)	17.1 (648)
NH black	31.1 (321) (.6–.9) [*]	19.6 (171) (.9–1.5)
Hispanic	24.0 (390) (.4–.6) ^{**}	13.1 (184) (.6–.9) [*]
NH Asian	17.7 (99) (.2–.5) ^{**}	9.5 (40) (.3–.8) [*]
NH other	39.4 (155) (.8–1.5)	20.1 (58) (.8–1.7)
Income category		
<100% FPL	34.9 (952) (1.3–1.9) ^{**}	19.0 (412) (1.1–1.8)
100%–<200% FPL	35.6 (669) (1.3–2.0) ^{**}	17.7 (237) (1.0–1.8)
200%–<400% FPL	30.2 (696) (1.0–1.5)	14.7 (260) (.8–1.4)
≥400% FPL ^{Ref}	26.8 (449)	14.3 (192)
Insurance status		
Full-year insured ^{Ref}	29.7 (2,090)	15.8 (883)
Partial-year uninsured	39.8 (353) (1.3–1.9) ^{**}	19.2 (123) (.9–1.6)
Full-year uninsured	36.6 (235) (1.1–1.9) [*]	13.1 (59) (.6–1.2)

Bolded values highlight significant differences.

Ref indicates referent group.

COVID-19 = coronavirus disease 2019; FPL = Federal Poverty Level; NH = non-Hispanic; NHIS = National Health Interview Survey; YA = young adult.

^a Significance and 95% confidence levels based on adjusted odds ratios adjusted for sex, race/ethnicity, income, insurance, and survey year, * $p < .01$, ** $p < .001$.

both $p < .001$. For the 200 to <400% FPL group (30%), the difference was not significant. Compared with the full-year insured group (30%), the vulnerability rates for the partial-year uninsured (40%) and full-year uninsured (37%) were significantly higher ($p < .001$ and $.01$, respectively).

Objective 2

Of the full sample (N = 8,405), 6,741 were nonsmokers (Table 2). The medical vulnerability rate for the nonsmoking group was 16%, half the rate of the full sample. Among nonsmokers, vulnerability was significantly higher among females (19%) versus males (13%), $p < .001$. Within race/ethnicity, compared with the white subgroup (17%), the Hispanic (13%) and Asian (10%) subgroups had lower vulnerability, both $p < .01$. Higher vulnerability in the black (20%) compared with the white subgroup was not significantly different. Within income groups, the lowest vulnerability rates were in the higher income groups: ≥400% FPL (14%), 200% to <400% FPL (15%), 100% to <200% FPL (18%), and <100% FPL (19%), with no significant differences.

Differences in vulnerability within insurance subgroups were not significant: full-year insured (16%), partial-year uninsured (19%), and full-year uninsured (13%).

Objective 3

Individual vulnerability indicator rates for the full sample varied widely (Tables 3 and 4). Three of the four highest estimates were for smoking indicators: past 30-day smoking (11%), current asthma (9%), past 30-day e-cigarette use (7%), and past 30-day cigar products use (5%). Lowest rates for individual indicators were for heart conditions and liver conditions, both rates <1.0%.

Significant sex differences were noted in five individual vulnerability indicators. The rates of current asthma were higher for females (10%) versus males (7%), $p < .01$; as were rates for immune conditions: females (3%) versus males (2%), $p < .001$. All three past 30-day smoking indicators were lower for females than males: smoking (9% for females vs. 13% for males), e-cigarette use (5% for females vs. 9% for males), and cigar products use (2% for females vs. 7% for males), all $p < .001$.

There were fewer racial/ethnic differences in the individual vulnerability indicators. For asthma, compared with the white subgroup (9%), the Hispanic subgroup had lower rates (6%), $p < .01$. For past 30-day smoking indicators, compared with the white subgroup (14%), the black (8%), Hispanic (7%), and Asian (5%) subgroups had lower rates, all $p < .001$; and the Hispanic subgroup (5%) had lower past 30-day cigarette use than the white subgroup (9%), $p < .001$.

Within income subgroup categories, differences were significant for one indicator: past 30-day smoking. Compared with the ≥400% FPL group (7%), the lower income groups had higher past 30-day smoking; <100% FPL = 13%; 100% to <200% FPL = 14%; and 200% to <400% FPL = 11%, p ranged from $.01$ to $.001$.

Within insurance subgroups, significant differences were noted in two vulnerability indicators. Compared with the full-year insured (3%), the partial-year uninsured (5%) had significantly higher body mass index ≥40 kg/m², $p < .01$ and for past 30-day smoking, compared with the full-year insured (9%), the partial-year uninsured (17%), and full-year uninsured (20%) had higher rates, both $p < .001$.

Discussion

The findings from this analysis indicate that nearly one in three young adults are medically vulnerable to severe COVID-19 illness (32%). In contrast, in the nonsmoking young adult group, only about one in six is medically vulnerable to severe COVID-19 illness (16%). This difference between estimates is driven largely by the sizable portion of young adults who reported that they engaged in past 30-day smoking (1 in 10) and past 30-day e-cigarette use (1 in 14). By contrast, relatively fewer young adults reported medical conditions identified by the CDC as conferring severe illness risk [5].

In the overall sample, findings from the subgroup analyses were driven by the prevalence of smoking. The findings from the analysis by sex show that overall severe COVID-19 illness medical vulnerability was higher for men than women. Higher rates of asthma and immune conditions among women were overshadowed by higher rates of engagement in smoking (cigarettes and/or cigars) and e-cigarette use in men than women. Among nonsmokers, by contrast, females were significantly more likely

Table 3

Young adult COVID-19 individual medical vulnerability conditions, ages 18–25 years, rates and differences NHIS 2016–2018

	Asthma (current), % (N) 95% CI	Heart condition, % (N) 95% CI	Immune condition ^b , % (N) 95% CI	Diabetes, % (N) 95% CI	Liver condition, % (N) 95% CI	BMI ≥40 kg/m ² , % (N) 95% CI
Full sample	8.6 (760)	.5 (34)	2.4 (212)	1.2 (101)	.6 (45)	3.0 (240)
Sex						
Female	10.0 (443) 1.1–1.7* ^a	.5 (16)	3.2 (144) 1.4–3.2**	1.2 (58)	.6 (20)	3.3 (149) .9–1.8
Male ^{Ref}	7.3 (317)	.6 (18)	1.6 (68)	1.1 (43)	.6 (25)	2.6 (91)
Race/ethnicity						
NH white ^{Ref}	9.2 (474)	.5 (18)	3.1 (154)	1.1 (60)	.5 (26)	2.7 (132)
NH black	11.0 (108) .9–1.6	.4 (3)	1.4 (18)	1.4 (15)	.3 (2)	4.4 (44) 1.1–2.7
Hispanic	6.2 (108) .5–.9*	.5 (9)	1.3 (21)	1.1 (15)	1.1 (15)	2.9 (44) .7–1.7
NH Asian	4.3 (21)	.1 (1)	1.0 (3)	.3 (3)	.1 (2)	.5 (2)
NH other	– 13.2 (49) 1.0–2.3	1.5 (3)	4.9 (16)	2.8 (8)	0 (0)	5.5 (18) –
Income category						
<100% FPL	10.7 (300) 1.0–1.8	.6 (10)	2.5 (68) .8–2.4	1.7 (46)	.6 (14)	3.2 (79) .9–2.7
100%–<200% FPL	8.6 (166) .8–1.4	.6 (9)	2.6 (51) .8–2.7	1.4 (22)	.4 (6)	3.6 (56) 1.0–3.1
200%–<400% FPL	7.6 (165) .7–1.2	.5 (8)	2.8 (61) .9–2.7	1.1 (24)	.6 (13)	3.1 (71) .9–2.5
≥400% FPL ^{Ref}	8.1 (129)	.5 (7)	1.8 (31)	.7 (8)	.7 (11)	2.1 (34)
Insurance status						
Full-year insured ^{Ref}	8.8 (623)	.5 (26)	2.5 (172)	1.1 (73)	.5 (32)	2.5 (172)
Partial-year uninsured	10.5 (85) .9–1.6	.5 (4)	2.2 (22)	2.4 (21)	1.1 (8)	4.5 (40) 1.2–2.9*
Full-year uninsured	5.1 (33) .4–.9	.9 (4)	1.6 (15)	1.1 (6)	.8 (4)	3.4 (17) –

Ref indicates referent group.

Italicized estimates and % indicate rate are not reliable because relative standard error (RSE) exceeds 25%, and bolded values highlight significant differences. COVID-19 = coronavirus disease 2019; FPL = Federal Poverty Level; NH = non-Hispanic; NHIS: National Health Interview Survey.

^a Significance and 95% confidence levels based on odds ratios; **p* < .01, ***p* < .001.^b Composite of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia.

to be medically vulnerable than males, because of their higher asthma and immune condition rates.

Patterns of other subgroup differences were similar between the overall sample and subsample of nonsmokers; however, significance levels sometimes differed. Analysis of differences by race/ethnicity generally showed higher vulnerability to severe COVID-19 illness for the white subgroup compared with the black, Hispanic, and Asian subgroups. For the full sample, this finding is largely because of whites' higher rates of smoking and e-cigarette use, a finding consistent with previous research showing lower smoking and e-cigarette use in minority populations [25,26]. Among nonsmokers, the white subgroup had higher medical vulnerability compared with the Hispanic and Asian subgroups; however, the significance was attenuated. The higher vulnerability rates within the lower income group compared with the highest income group, seen in the full sample, were not present in the nonsmoking sample, suggesting that smoking accounted for the income differences, illustrated by nearly double past 30-day smoking rates for the lowest income group compared with the highest income group. The finding in the full sample of higher medical vulnerability within the partial-year and full-year uninsured groups compared with the full-year insured is also not seen in the nonsmoking sample, again suggesting that smoking and/or e-cigarette use accounted for the differences within insurance groups.

Overall, a key finding is that the most prevalent factor conferring medical vulnerability to severe COVID-19 illness

among young adults is smoking. Notably, the risk of being medically vulnerable is halved when smokers, including e-cigarette users, are removed from the sample. Efforts to reduce smoking and e-cigarette use among young adults would likely reduce their medical vulnerability to severe illness. Our analysis suggests that risk from smoking and e-cigarette use is highest among young adults who are male, white, and lower income and who are fully or partially uninsured.

Our finding of lower medical vulnerability of racial/ethnic minorities compared with the white subgroup, despite controlling for income and insurance status, was unexpected. It is inconsistent with research showing higher rates of COVID-19 morbidity and mortality and other chronic illnesses among racial/ethnic minorities, nonspecific to one age group [4,27–29]. It is also inconsistent with mortality data for 15- to 24-year-olds, an age group similar to the young adult age group, where Hispanics and blacks lead all other ethnic and racial groups in COVID-19 deaths [30]. This suggests that factors other than the CDC's medical vulnerability criteria play a role in the risk of severe COVID-19 illness in the young adult population. A social determinants of health framework may help identify additional factors that potentially confer greater risk of severe COVID-19 illness, such as increased exposures to the virus through working in settings that involve crowded or continued close contact with other employees or with the general public and high household occupancy living conditions [31,32]. The examination of these and other factors may be a useful complement to this

Table 4

Young adult COVID-19 individual smoking-related medical vulnerability full sample, ages 18–25 years, rates and differences NHIS 2016–2018

	Past 30-day smoking, % (N) 95% CI	Past 30-day e-cigarette use, % (N) 95% CI	Past 30-day smoking cigar products, % (N) 95% CI
Full sample	10.9 (1,022)	7.2 (623)	4.5 (427)
Sex			
Female	9.1 (457)	5.2 (216)	1.9 (92)
Male ^{Ref}	<i>.6–.8***</i>	<i>.4–.7**</i>	<i>.2–.4**</i>
Race/ethnicity			
NH white ^{Ref}	13.7 (711)	9.2 (449)	4.8 (280)
NH black	8.2 (95)	2.8 (27)	6.1 (54)
Hispanic	6.6 (123)	4.8 (76)	3.5 (59)
NH Asian	4.5 (34)	5.5 (30)	1.1 (11)
NH other	14.3 (59)	10.0 (41)	5.5 (23)
Income category			
<100% FPL	12.7 (327)	6.5 (193)	5.4 (158)
100–<200% FPL	14.2 (289)	7.0 (147)	5.0 (93)
200–<400% FPL	10.7 (279)	8.0 (169)	4.6 (112)
≥400% FPL ^{Ref}	7.0 (127)	7.1 (115)	3.3 (64)
Insurance status			
Full-year insured ^{Ref}	9.2 (694)	6.9 (476)	4.2 (323)
Partial-year uninsured	17.1 (164)	9.4 (74)	6.2 (56)
Full-year uninsured	20.0 (136)	7.0 (48)	5.6 (33)
	<i>1.6–2.6**</i>	<i>1.0–1.9</i>	<i>1.1–2.2</i>
	1.9–3.3**	<i>.7–1.6</i>	<i>.9–2.2</i>

Ref indicates referent group.

Italicized estimates and % indicate estimate are not reliable because relative standard error (RSE) exceeds 25%, and bolded values highlight significant differences. COVID-19 = coronavirus disease 2019; FPL = Federal Poverty Level; NH = non-Hispanic; NHIS = National Health Interview Survey.

^a Significance and 95% confidence levels based on odds ratios; **p* < .01, ***p* < .001.

study's focus on using the CDC's criteria to assess medical vulnerability among young adults.

This study provides an initial estimate of young adult medical vulnerability to severe COVID-19 illness. However, the lack of information about prevalence, hospitalization, and deaths for young adults aged 18–25 years limits our ability to determine whether the conditions within the overall CDC vulnerability measure are the appropriate conditions to consider. Low rates of most chronic illnesses reported in the young adult sample rendered many subcategory rates unstable, limiting our ability to assess subgroup differences fully for individual indicators. However, analyses of differences among stable individual subcategories were not affected by the presence of unstable subcategories, thus allowing for some subgroup comparisons. The NHIS data provide national estimates for the U.S. civilian noninstitutionalized population; thus, it lacks representation of incarcerated adults, who are disproportionately members of minority groups [33,34]. As the result, it may underestimate vulnerability rates for ethnic/racial subgroups of young adults. In addition, the NHIS 2016–2018 data are at least 1.5 years old, and estimates of these vulnerability indicators could be different now. The CDC vulnerability list identifies those with moderate or severe levels of asthma as higher risk; however, the NHIS definition of current asthma does not include assessment of asthma severity level.

Nearly one in three young adults is medically vulnerable to severe COVID-19 illness. To further our understanding of the impact of COVID-19 on young adults, these findings need to be

compared with other indicators related to severe COVID-19 illness, such as hospitalization rates and mortality. Reporting on these indicators for the young adult age group would help inform a public health response that takes this unique age group into account.

Smoking is a key factor that confers medical vulnerability among young adults. Smoking and e-cigarette use, as well as obesity, are also known risk factors for many serious health conditions, including heart disease, diabetes, and respiratory diseases. However, they are often difficult to modify [35]. This points to the importance of preventive services and interventions in these areas for children and adolescents and of risk reduction efforts at any age. Such interventions have the potential to reduce medical vulnerability to severe COVID-19 illness and other serious health conditions.

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