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Preferred Language Mediates Association Between Race, Ethnicity, and Delayed Presentation in Critically Ill Patients With COVID-19

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IMPORTANCE: Which social factors explain racial and ethnic disparities in COVID-19 access to care and outcomes remain unclear.

OBJECTIVES: We hypothesized that preferred language mediates the association between race, ethnicity and delays to care.

DESIGN, SETTING AND PARTICIPANTS: Multicenter, retrospective cohort study of adults with COVID-19 consecutively admitted to the ICU in three Massachusetts hospitals in 2020.

MAIN OUTCOME AND MEASURES: Causal mediation analysis was performed to evaluate potential mediators including preferred language, insurance status, and neighborhood characteristics.

RESULTS: Non-Hispanic White (NHW) patients (157/442, 36%) were more likely to speak English as their preferred language (78% vs. 13%), were less likely to be un- or under-insured (1% vs. 28%), lived in neighborhoods with lower social vulnerability index (SVI) than patients from racial and ethnic minority groups (SVI percentile 59 [28] vs. 74 [21]) but had more comorbidities (Charlson comorbidity index 4.6 [2.5] vs. 3.0 [2.5]), and were older (70 [13.2] vs. 58 [15.1] years). From symptom onset, NHW patients were admitted 1.67 [0.71–2.63] days earlier than patients from racial and ethnic minority groups ($p < 0.01$). Non-English preferred language was associated with delay to admission of 1.29 [0.40–2.18] days ($p < 0.01$). Preferred language mediated 63% of the total effect ($p = 0.02$) between race, ethnicity and days from symptom onset to hospital admission. Insurance status, social vulnerability, and distance to the hospital were not on the causal pathway between race, ethnicity and delay to admission.

CONCLUSIONS AND RELEVANCE: Preferred language mediates the association between race, ethnicity and delays to presentation for critically ill patients with COVID-19, although our results are limited by possible collider stratification bias. Effective COVID-19 treatments require early diagnosis, and delays are associated with increased mortality. Further research on the role preferred language plays in racial and ethnic disparities may identify effective solutions for equitable care.

KEY WORDS: COVID-19; casual inference; critical care; disparities; mediation analysis

The impact of the COVID-19 pandemic has been profoundly uneven, with marginalized racial and ethnic groups bearing a disproportionate burden of the morbidity and mortality (1–5). Additionally, the disparities in outcomes extend beyond race and ethnicity, including many social and

DOI: 10.1097/CCE.0000000000000927

KEY POINTS

Question: Noting widely reported COVID-19-related racial and ethnic disparities, we sought to use causal mediation analysis to determine if social vulnerability, insurance type, or preferred language were driving these differences.

Findings: In this multicenter, retrospective cohort study we found that preferred language mediates a large portion of the observed disparities in delay to presentation in COVID-19 in racial and ethnic minority groups.

Meaning: Improving access to care based on preferred language may represent an important tool to improve disparities in COVID-19 outcomes based on race and ethnicity.

demographic factors: residential crowding (6), social vulnerability (1, 7), socioeconomic status (1, 8), preferred language (9), education level (10), and access to testing (11). Furthermore, the development of novel COVID-19 treatments that require early administration after symptom onset has heightened the importance of understanding disparities in access to testing and care (12–15).

Identifying modifiable factors amenable to intervention to reduce or eliminate disparities remains critical. Yet, as race and ethnicity often intersect and covary with other social and demographic factors, it is challenging to elucidate which specific factors drive disparities (1, 6, 10, 16). One tool that can improve our understanding of the relationship between a factor and an outcome in the presence of other possible explanatory variables is causal inference (17–19). Specifically, one causal inference approach, mediation analysis clarifies assumptions and provides statistical techniques for decomposing the total effect of an exposure (e.g., self-reported race) on an outcome (e.g., severity of illness) into direct effects—those directly caused by the factor—and indirect effects—those caused by a third mediating variable (e.g., access to testing) (17–19). The ability of these techniques to determine which factors mediate relationships between an exposure and an outcome enhances conclusions and gives more credence to the selection of potential interventions targeting the identified drivers of disparities.

We hypothesized that critically ill patients with COVID-19 who belong to racial and ethnic minority groups would have delayed time from symptom onset to testing and hospital admission. Using causal inference, we identified mediators contributing to these delays in accessing care.

MATERIALS AND METHODS

Study Design and Data Abstraction

We performed a retrospective cohort study at three Boston-area hospitals of all patients with COVID-19 consecutively admitted to the ICU between March and May 2020. These hospitals represented both community and tertiary care hospitals within the Mass General Brigham system. Inclusion criteria were admission to the ICU, a clinical syndrome consistent with COVID-19, and detection of severe acute respiratory syndrome coronavirus 2 via polymerase chain reaction. The study protocol was approved by the institutional review board at Massachusetts General Hospital (2020P001119).

Data were manually abstracted from electronic health records. Data abstractors were trained in the use of the standardized data abstraction tool (Research Electronic Data Capture) and were unaware of the study hypothesis. Manually abstracted variables included patient demographics, insurance status, preferred language, medical history, and admission details. Race and ethnicity were self-identified or identified by a family member. Preferred language was verified by cross-referencing requests for medical interpreter services. Insurance status at the time of admission was verified by cross-referencing notes from case management and social work. The Charlson Comorbidity Index (CCI) (20) and Sequential Organ Failure Assessment (SOFA) (21, 22) scores were calculated based on data at the time of hospital admission.

Home addresses at the time of hospital admission were geocoded confidentially using Decentralized Geomarker Assessment for Multisite Studies (23). Home addresses were mapped to Federal Information Processing System (FIPS) codes. Neighborhood-level data and Social Vulnerability Index (SVI) were abstracted from the 2018 Massachusetts Census database by FIPS code (24). Distance to hospital was calculated as direct linear distance (i.e., as the crow flies) based on distance from home address to the hospital the patient was admitted to.

Outcome Measures

The primary outcome was time (in days) between onset of symptoms and hospital admission. Secondary outcomes included time from symptom onset to testing, ventilator-free days at 30 days, and death. Patients that died or still remained on a ventilator at 30 days were noted as having zero ventilator-free days (25).

Statistical Analysis

Dichotomous groups were created to measure disparity across race and ethnicity. These included: Hispanic and non-Hispanic White (NHW), Black and NHW, Black or Hispanic and NHW, and NHW and any other combination of race and ethnicity, to best identify disparities between traditionally marginalized and nonmarginalized groups (1, 2, 4–6, 8, 26). To maximize power in identifying drivers of disparity and to focus our comparisons to the most privileged group (NHW), the primary analysis explored comparisons of NHW with any other combination of race and ethnicity. Secondary analyses included: Hispanic and NHW, Black and NHW, and Black or Hispanic and NHW.

Social vulnerability was modeled both as a continuous variable (percentile rank of SVI) and dichotomously (≥75th percentile) (7, 27). Distance from residence to the hospital was heavily right-skewed (mean distance 6.0 miles; median distance 3.6 miles), with 89% of the study population living within 10 miles of the hospital they were admitted to. We elected to model distance dichotomously to adjust for this skew (≥3.6 miles from the hospital; the median distance from the hospital). Insurance status was modeled dichotomously as either insured or under-insured. Under-insured included uninsured patients or those with MassHealth Limited. MassHealth Limited is a form of government-sponsored emergency insurance provided to those whose immigration status prevents them from accessing more services (28). All variables had less than 10% missing data, and demographics were similar between those with and without missing data, thus no corrections or imputations were used for missing data (**Table E1**, http://links.lww.com/CCX/B204).

Covariates were included based on a priori assumption of relevance to the outcome of interest. Age, sex, CCI, and distance from residence to the hospital were included as covariates for regression analyses for the primary outcome. For the secondary outcomes of death and ventilator-free days, age, sex, CCI, and admission SOFA were included as covariates in any regression analyses for the secondary outcomes of ventilator-free days and mortality.

Causal mediation analysis was performed to identify factors in the causal pathway between race and ethnicity and delays in seeking care. Potential mediators were tested individually and included preferred language, insurance status, and SVI. For all mediation models, age, sex, CCI, and distance to the hospital were included as covariates (**Fig. E1**, http://links.lww.com/CCX/B204). CIs were obtained based on 10,000 bootstrapped samples. All mediation models tested for potential exposure-mediator interactions. Statistical analyses were performed in R (R version 4.1.3; R Foundation for Statistical Computing, Vienna, Austria). Mediation analysis was performed using the CMAVerse package (29). The E-value was estimated to explore the potential impact of unmeasured confounding (30). As we hypothesized a priori that social vulnerability and insurance status would be relevant to our model, these variables were included in the mediation analysis as covariates in sensitivity analyses. All tests were two-tailed with alpha set at 0.05. All R code for the analysis has been provided and is available for review.

RESULTS

Baseline Characteristics of the Cohort

Of 460 critically ill patients with COVID-19 in the study, NHW patients represented less than half (157/442, 36%) of the cohort. NHW patients had more comorbidities (mean CCI [SD]: 4.6 [2.5] vs 3.0 [2.5]), were older (70 [13.2] vs 58 [15.1] yr), were more likely to speak English as their preferred language (78% vs 13%), were less likely to be uninsured or under-insured (1% vs 28%), and lived in wealthier neighborhoods (mean per capita income, $42,321 [$18,258] vs $31,168 [$13,006]) with lower social vulnerability (mean percentile rank of total SVI, 59 [28] vs 74 [21]; **Table 1**). SVI, preferred language, insurance status, and race and ethnicity were highly correlated (**Fig. E2**, http://links.lww.com/CCX/B204). Overall, patients presented for COVID-19 testing 5.4 (SD = 4.8) days after symptom onset and were admitted to the hospital an

TABLE 1.
Baseline Characteristics of Study Population Stratified by Race and Ethnicity

	Non-Hispanic White (*n* = 157)	Racial and Ethnic Minority Groups (*n* = 285)
Baseline characteristics		
Age, mean (SD)	70.0 (13.2)	57.9 (15.1)
Female, *n* (%)[a]	58 (37)	58 (49)
Race, *n* (%)[b]		
American Indian, Alaska Native, or Native Hawaiian	–	4 (1.4)
Asian	–	23 (8.3)
Black or African American	–	75 (26)
Other or mixed	–	58 (20)
White	157 (100)	118 (42)
Hispanic, *n* (%)[c]	–	195 (71)
Non-English preferred language, *n* (%)	21 (13)	223 (78)
Spanish	2 (1.3)	179 (63)
Haitian Creole	0 (0)	20 (7.0)
Khmer	0 (0)	7 (2.5)
Portuguese	3 (1.9)	2 (0.7)
Arabic	4 (2.5)	1 (0.3)
Social vulnerability, mean percentile rank (SD)[d]	59 (28)	74 (21)
Neighborhood per capita income, mean (SD)[d]	$42,321 (18,258)	$31,238 (13,006)
Uninsured or under-insured, *n* (%)	2 (1.3)	80 (28.1)
Distance to hospital (miles), mean (SD)[d]	7.8 (11.9)	4.6 (4.9)
Body mass index, mean (SD)[a]	31.4 (7.8)	30.7 (7.0)
Charlson Comorbidity Index, mean (SD)	4.6 (2.5)	3.0 (2.5)
Clinical outcomes		
Symptom onset to testing (d), mean (SD)	4.3 (4.9)	5.8 (4.5)
Symptom onset to admission (d), mean (SD)	5.3 (5.1)	6.9 (4.7)
Symptom onset to intubation (d), mean (SD)[d]	7.7 (5.9)	8.5 (5.1)
Admission to intubation (d), mean (SD)[d]	2.2 (3.3)	1.6 (2.5)
Sequential Organ Failure Assessment Score on admission to ICU, mean (SD)	6.5 (3.0)	6.2 (3.3)
PaO_2:FIO_2 on admission to ICU, mean (SD)	185 (93.2)	175 (79.0)
Days on ventilator, mean (SD)[e]	14.5 (7.9)	15.3 (7.9)
ICU length of stay (d), mean (SD)	16.4 (12.7)	20.2 (17.2)
Died within 30 d, *n* (%)	71 (45)	56 (20)
Died within 90 d, *n* (%)	73 (47)	70 (25)
Died, *n* (%)	75 (48)	72 (25)

[a]*n* missing = 1.
[b]*n* missing = 12.
[c]*n* missing = 23.
[d]*n* missing = 20.
[d]*n* missing = 37.
[e]*n* missing = 45.
Summary of statistics are presented as *n* (%) or mean (SD).

average of 6.5 [5.0] days after symptom onset. Delays to testing and admission were highly correlated (R^2 = 0.76, $p < 0.001$). Compared to NHW patients, patients from racial and ethnic minority groups had a greater delay in the time from symptoms onset to testing (4.3 [4.9] vs 5.8 [4.5] d), admission (5.3 [5.1] vs 6.9 [4.7] d) but were intubated more quickly after admission (2.19 [3.3] vs 1.6 [2.5] d; Table 1).

Associations Between Demographics and Delays to Testing and Admission

In multivariable linear regression analysis, NHW patients sought testing 1.45 (95% CI, [0.49–2.42]) days earlier and were admitted 1.67 (0.71–2.63) days earlier after symptom onset than patients from racial and ethnic minority groups. Patients with a non-English preferred language had a testing delay of 1.07 (0.19–1.96) days and admission delay of 1.29 (0.40–2.18) days, compared with patients whose preferred language was English. Insurance status, neighborhood SVI, and distance to the hospital were not associated with differences in time to testing or admission (**Table 2**).

The Mediating Relationship of Preferred Language Between Race, Ethnicity, and Time to Presentation

Mediation analysis demonstrated a total effect of race and ethnicity on time from symptom onset to admission of +1.68 (0.71–2.59) days (**Table 3**) that was mediated by preferred language. Preferred language was a mediator of the relationship between race, ethnicity, and delay to admission (indirect effect: +1.05 [0.14–1.81] d). Preferred language-mediated 63% of the total effect ($p = 0.02$; **Fig. 1**). After adjusting for mediation by preferred language, the direct effect (the effect of race and ethnicity on delay to admission not caused by preferred language) was +0.63 (−0.52 to 1.87) d (**Table E2**, http://links.lww.com/CCX/B204). In contrast, insurance status and SVI were not found to be significant mediators of the causal pathway between race, ethnicity, and delay to admission (**Table E3**, http://links.lww.com/CCX/B204).

Similar results were observed in evaluating time from symptom onset to COVID-19 testing. The total effect of race and ethnicity on delay to testing was 1.46 [0.51–2.40] days (**Table 4**). Preferred language-mediated this relationship (indirect effect: +0.91 [0.15–1.71] d), mediating 63% of the total effect ($p = 0.02$; **Fig. 2**). As with delay to admission, the direct effect of race and ethnicity was +0.54 [−0.67 to 1.72] days (**Table E4**, http://links.lww.com/CCX/B204), and insurance status and SVI were not found to be significant mediators (**Table E5**, http://links.lww.com/CCX/B204).

To assess robustness of our findings, multiple sensitivity analyses were performed. E-value measurement seeks to determine how large the magnitude of the effect from an unmeasured confounder would need to be to nullify the observed results. E-value demonstrated that an unmeasured confounder with an effect 1.72 times as large as the effect of preferred language ([E-value 95% CI lower limit]; [1.24]; **Table E6**, http://links.lww.com/CCX/B204) would be required to nullify the results of the indirect effect of preferred language on delay to admission. Addition of SVI and insurance status as covariates in the mediation analysis resulted in similar associations between race, ethnicity, and delay to care (**Table E7**, http://links.lww.com/CCX/B204).

To further identify the role of specific race and ethnicity comparisons, we performed subgroup analyses focused on patients identifying as Black or Hispanic given data identifying disparities particularly in these groups compared with those identifying as NHW (1, 2). Looking at patients identifying as either Black or Hispanic (n = 251) versus NHW (n = 157), similar results were observed for the role of preferred language as a mediator (**Table E8**, http://links.lww.com/CCX/B204). Looking solely at Hispanic (n = 176) versus NHW (n = 157) patients also yielded analogous effect sizes (**Table E9**, http://links.lww.com/CCX/B204). However, when looking at Black (n = 75) versus NHW (n = 157), the relationship of preferred language as a significant mediator was no longer observed (**Table E10**, http://links.lww.com/CCX/B204) although our sample size was more limited for this comparison.

Ventilator-Free Days and Mortality

Overall, the mean ventilator-free days within 30 days were 10.8 [9.7]. One hundred thirty-two (29%) of patients had died within 30 days and 148 (32%) had died within 90 days of hospital admission. In adjusted analyses, race, ethnicity, preferred language, social

TABLE 2.
Univariate and Multivariable Regression of Demographics Predicting Delay to Testing and Delay to Admission

	Unadjusted β (95% CI)	*p*	Adjusted β (95% CI)	*p*
Outcome = delay from symptom onset to testing (d)[a]				
Race and ethnicity	1.55 (0.64 to 2.45)	< 0.001	1.45 (0.49 to 2.42)	< 0.01
Preferred language	1.18 (0.30 to 2.06)	0.01	1.07 (0.19 to 1.96)	0.02
Social vulnerability	0.29 (–1.41 to 1.99)	0.74	0.30 (–1.38 to 1.98)	0.73
Insurance status	0.67 (–0.49 to 1.82)	0.26	0.34 (–0.89 to 1.58)	0.59
Distance to hospital	–0.03 (–0.90 to 0.84)	0.94	0.14 (–0.71 to 0.99)	0.74
Outcome = delay from symptom onset to admission (d)[b]				
Race and ethnicity	1.60 (0.66 to 2.53)	< 0.001	1.67 (0.71 to 2.63)	< 0.01
Preferred language	1.06 (0.15 to 1.97)	0.02	1.29 (0.40 to 2.18)	< 0.01
Social vulnerability	0.46 (–1.28 to 2.20)	0.61	0.44 (–1.31 to 2.19)	0.62
Insurance status	0.77 (–0.42 to 1.95)	0.21	0.18 (–1.06 to 1.42)	0.78
Distance to hospital	0.10 (–0.79 to 0.99)	0.82	0.31 (–0.55 to 1.17)	0.48

[a]Multivariable logistic regression model adjusting for age, sex, and Charlson Comorbidity Index as covariates.
[b]Multivariable logistic regression model adjusting for age, sex, Charlson Comorbidity Index, and distance to the hospital as covariates.

TABLE 3.
Mediation Analysis Results of Race and Ethnicity Predicting Delay to Presentation Mediated by Preferred Language

Predictor = Race and Ethnicity (Ref = Non-Hispanic White) Mediator = Preferred Language (Ref = English) Outcome = Symptom Onset to Admission (d)		
	Estimate β (d) (95% CI)	*p*
Pure natural direct effect	0.63 (–0.52 to 1.87)	0.27
Total natural indirect effect	1.05 (0.14 to 1.81)	0.02
Total effect	1.68 (0.71 to 2.59)	< 0.01

All models adjusting for age, sex, Charlson Comorbidity Index, and distance to the hospital as covariates.

vulnerability, insurance status, and distance from residence to the hospital were not significant predictors of ventilator-free days or mortality (**Table E11**, http://links.lww.com/CCX/B204).

DISCUSSION

In a cohort of critically ill patients with COVID-19, differences in preferred language-mediate race and ethnicity-related disparities in presentation to care. Utilizing mediation analysis, we observed that 63% of the total effect of race and ethnicity on delayed care is mediated by preferred language. This study suggests that improving access to care based on preferred language may be an important target for future interventions to reduce and eliminate disparities in patients with COVID-19.

Early diagnosis is required for eligibility for multiple effective COVID-19 therapies. Studies show increased efficacy of these interventions when treatment is started sooner (12, 31, 32). Thus, it is critical that we decrease disparities in the time from symptoms onset to testing and accessing medical care (12, 15, 33). In our cohort, patients from racial and ethnic minority

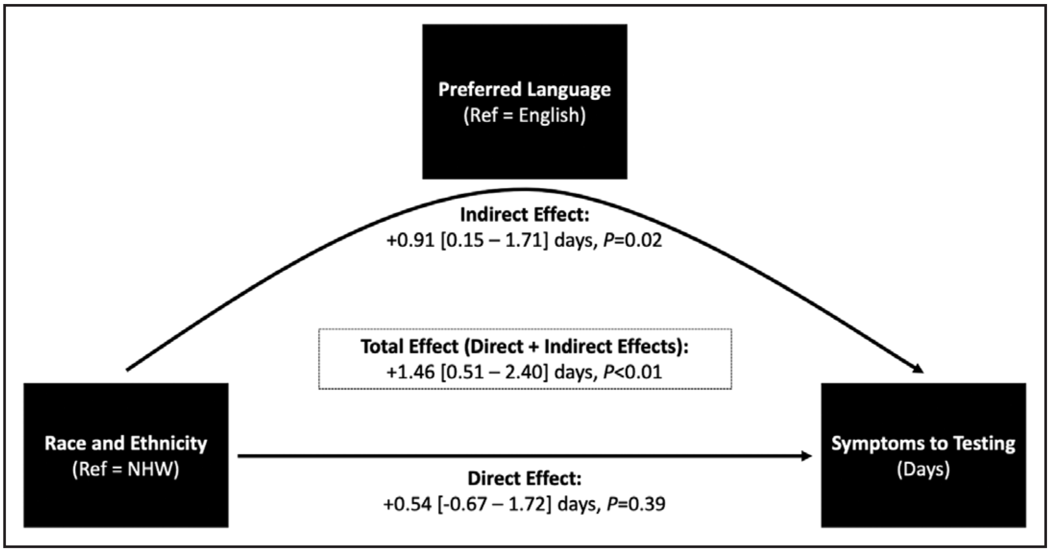

Figure 1. Mediation analysis of race and ethnicity predicting delay to admission, mediated by preferred language. Preferred language was shown to be a significant mediator of the relationship between race, ethnicity, and delay to admission (indirect effect: +1.05 [0.14–1.81] d, $p = 0.02$), mediating 63% of the total effect ($p = 0.02$). Independent of language, race, and ethnicity did not significantly increase delay to presentation (direct effect: +0.63 [–0.52 to 1.87] d, $p = 0.27$). Mediation analysis was performed using two regression models: race and ethnicity (Non-Hispanic White [NHW] vs racial and ethnic minority groups) predicting non-English preferred language and days from symptom onset to admission predicted from race and ethnicity and preferred language (including interaction term). NHW was used as reference for race and ethnicity; English was used as reference for preferred language. All models were calculated using age, sex, Charlson Comorbidity Index, and distance to the hospital as potential covariates. Estimates and CIs calculated using CMAverse package in R using 10,000 bootstraps.

groups sought testing and were admitted later, yet upon admission they were more quickly intubated than NHW patients. This finding suggests that delayed presentation to care was potentially detrimental. Other studies show that delayed admission to the ICU is associated with increased mortality; an observational study showed that each 1-hour increase in delay was associated with an adjusted 3% increase in odds of hospital mortality (34, 35). In our cohort, NHW were older and with more comorbidities and we suspect this is why mortality was not different between NHW and patients from racial and ethnic minority groups.

We observed differences in preferred language, social vulnerability, insurance status, and distance to hospital based on race and ethnicity, consistent with prior studies (1, 6, 9–11). Our analysis expands upon this prior work by using mediation analysis to focus on factors that mediated the observed disparities. We identified that preferred language drives the disparity based on race and ethnicity, while social vulnerability, insurance status, and distance to hospital were not in the causal pathway. This contrasts with other work that has demonstrated that social factors may explain up to 27% of racial and ethnic disparities in COVID-19-related test positivity and hospitalization (8). Although a larger study or a study performed in a different context may show different results, our findings nevertheless highlight language as a potential priority target for potential interventions to reduce disparities.

There are several potential mechanisms through which preferred language may explain disparities in medical care. At the time of this study, home testing was not available, and obtaining COVID-19 testing required accessing rapidly shifting information. Since much of this information was released first (or only) in English, language preference could have exacerbated disparities in access to information and testing (36–38). Trust in information may also play a role, as this has been shown to vary by race, ethnicity, and language (36, 37). Other work has highlighted how Black and Hispanic individuals are over-represented as essential workers, which could impact testing and care-seeking decisions (39). Immigration status has been shown to decrease both access to care and care-seeking behavior (40). Although immigration status was not directly recorded in our database, 17.5% of those in racial and ethnic minority groups had MassHealth Limited insurance, an emergency form of insurance for those whose immigration status precludes other forms of adequate insurance (28, 38). However, insurance status was not shown to be a significant mediator of racial and ethnic disparity in time from symptom onset to testing or admission in our cohort. To better understand which aspect of language contributed to these

TABLE 4.
Mediation Analysis Results of Race and Ethnicity Predicting Delay to Testing Mediated by Preferred Language

Predictor = Race and Ethnicity (Ref = Non-Hispanic White) Mediator = Preferred Language (Ref = English) Outcome = Symptom Onset to Testing (d)		
	Estimate β (d) (95% CI)	*p*
Pure natural direct effect	0.54 (–0.67 to 1.72)	0.39
Total natural indirect effect	0.91 (0.15 to 1.71)	0.02
Total effect	1.46 (0.51 to 2.40)	$<$ 0.01

All models adjusting for age, sex, and Charlson Comorbidity Index as covariates.

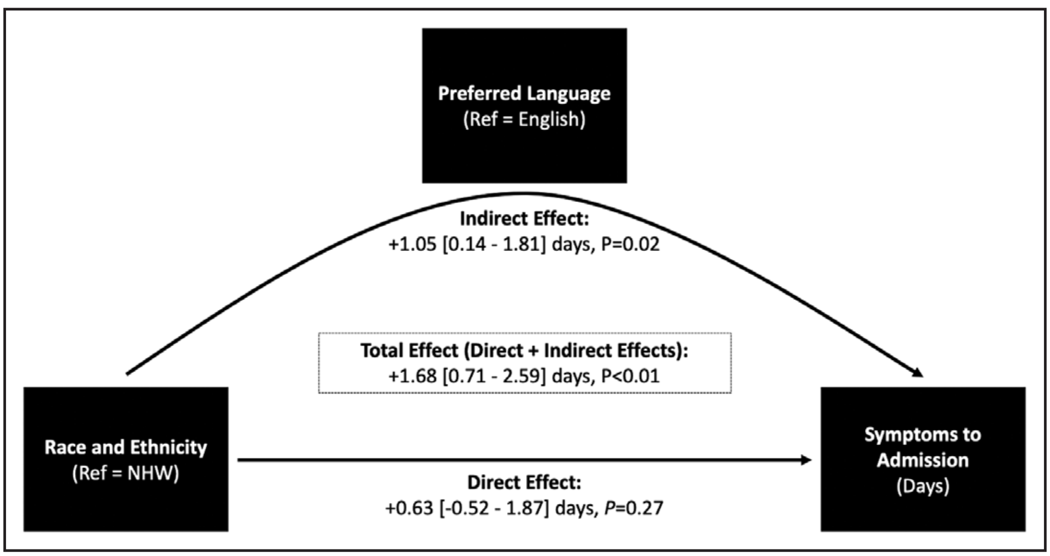

Figure 2. Mediation analysis of race and ethnicity predicting delay to testing, mediated by preferred language. Preferred language was shown to be a significant mediator of the relationship between race, ethnicity, and delay to testing (indirect effect: +0.91 [0.15–1.71] d, $p = 0.02$), mediating 62% of the total effect ($p = 0.02$). Independent of language, race, and ethnicity did not significantly increase delay to testing (direct effect: +0.54 [–0.67 to 1.72] d, $p = 0.39$). Mediation analysis was performed using two regression models: race and ethnicity (Non-Hispanic White [NHW] vs racial and ethnic minority groups) predicting non-English preferred language and days from symptom onset to testing predicted from race and ethnicity and preferred language (including interaction term). NHW was used as reference for race and ethnicity; English was used as reference for preferred language. All models were calculated using age, sex, and Charlson Comorbidity Index covariates. Estimates and Cis were calculated using CMAverse package in R using 10,000 bootstraps.

disparities, qualitative studies are an important next step in the design of future interventions to address these disparities.

We did not observe racial or ethnic disparities in ventilator-free days or mortality, unlike other studies (1–5). There are several potential explanatory factors. First, NHW patients in our cohort were older and had more baseline comorbidities than patients identifying as members of racial and ethnic minority groups. Second, our cohort represents patients hospitalized in 2020, when no COVID-specific treatments were available, limiting the potential benefit of earlier diagnosis. Furthermore, studies have shown that even when prehospitalization disparities existed, posthospitalization disparities were attenuated, possibly due to hospital protocols that standardized COVID-19-related care (41, 42). Third, it is possible that the lack of observed disparity could be indicative of residual confounding. Lastly, we were underpowered to evaluate mortality as a primary outcome.

Mediation analysis relies on strong assumptions, particularly that analyses should adjust for exposure-outcome, exposure-mediator, and mediator-outcome confounders. Further, there should be no confounders of the mediator-outcome relationship affected by the exposure. In the context of health disparities research, such assumptions can be weakened as there is no interest in intervening to modify race or ethnicity as an "exposure." A weaker interpretation of the effects is discussed in Valeri et al (43) for which only the assumption of no mediator-outcome relationship is required. In our study, we focused on adjusting for confounders of the mediator-outcome relationship, namely age, sex, comorbidities, and distance from the hospital. Thus, weaker interpretations of direct and indirect effects are as follows: the direct effect can be interpreted as the residual racial disparity after intervening and fixing the mediator distribution to be the same across racial and ethnic groups. The indirect effect can be interpreted as the change in the outcome due to a shift in the mediator distribution from what is observed in the least advantaged population to what is observed in the most advantaged.

Our work should be interpreted in context of its strengths and limitations. A strength of our results is the use of a manually curated database, allowing us to identify factors not present in large administrative databases such as the date of symptom onset.

A major limitation of our study design is that we included only patients who required admission to the ICU. Conditioning on ICU admission, which is a descendent of our primary outcome (time from symptom onset to hospital admission) and may be a common effect of exposure (race and ethnicity), may lead to collider stratification, or selection bias (**Fig. E3**, http://links.lww.com/CCX/B204) (44). More specifically, if race, ethnicity, or preferred language are associated with delayed time to hospital admission and an increased risk of ICU admission, adjusting for ICU admission (based on our study design which includes only patients who ultimately required ICU care) may lead to a biased estimate of the association between minority status or preferred language and delayed presentation to the hospital. Even if we had access to data from COVID-19 patients who did not require ICU admission, this design would still condition sick patients who nevertheless were healthy enough to survive hospital admission or presentation to a healthcare provider. Our study was conducted during the first wave of the COVID-19 pandemic when there was a rise in excess out-of-hospital sudden deaths (41–43).

An alternative approach to address collider bias would be to focus on post-ICU-related outcomes. However, in this article we wanted to focus on time to hospital admission as the outcome because some studies have shown that disparities exist in events leading to hospital admission (e.g., triage decisions and access to testing) (11, 41). After accessing care, such disparities are lessened likely due to the decision by many hospital systems (including our own) to institute protocolized care for COVID-19 patients (41, 42, 45). In addition, to our knowledge, there is currently no implementation of mediation analysis software that can account for a binary predictor and a time-to-event model for ICU length of stay that can account for important competing risks such as death (44). Although development of such a tool is outside the scope of this article, it would be an important focus of future work for causal inference approaches to be applied to critical care research.

We are also limited in that the cohort represented only patients from Massachusetts. Social vulnerability estimates were obtained at the neighborhood level by geocoding home addresses, which may be distinct from individual-level social vulnerability and thus lead to exposure misclassification. Although a prospective study design may address this issue, often this type of study design may raise other concerns such as selection bias due to nonparticipation or arising from participants declining to answer questions related to socioeconomic status. Given the timing of the study in 2020, the effect of vaccination and increased access to home testing remain unknown. In addition, we were underpowered to study differences for individual races, ethnicities, and languages thus our primary predictor relied on grouping patients into a binary category.

In summary, differences in preferred language appear to drive racial and ethnic disparities in delayed presentation to care in critically ill patients with COVID-19. Further research into the role preferred language plays in racial and ethnic disparities may identify effective solutions for equitable care.

ACKNOWLEDGMENTS

We thank all nursing staff, respiratory therapists, medical interpreter services and members of the Pulmonary and Critical Care Divisions and Departments of Anesthesiology, trainees, and hospital support staff and administration across all three hospitals for the tireless care they provided to all patients with COVID-19. This work would not be possible if not for the excellent care they provided.

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Drs. Kelly, Mohammed, and Lai conceptualize. Drs. Kelly, Mohammed, Okin, Alba, Jesudasen, Dandawate, Gavralidis, Chang, Moin, Witkin, Hibbert, Kadar, Gordan, Lai, and Bebell were involved in data curation. Drs. Kelly, Mohammed, Hauptman, Flanagan, and Lai were involved in formal analysis. Drs. Kelly and Lai contributed to funding acquisition Drs. Kelly, Mohammed, Hauptman, Flanagan, Valeri, Bebell, and Lai were involved in methodology Dr. Kelly involved in writing–original draft. Drs. Kelly, Mohammed, Okin, Alba, Jesudasen, Flanagan, Dandawate, Gavralidis, Chang, Moin, Witkin, Hibbert, Kadar, Gordan, Hauptman, Valeri, Bebell, and Lai were involved in writing–review and editing.

Dr. Kelly is supported by R38 HL150212-01 from the National Institutes of Health. Dr. Lai is supported by R01 AI144119 from the National Institutes of Health. Dr. Okin is supported by T32 HL116725 from the National Institutes of Health. Dr. Witkin received compensation for consulting for United Therapeutics (who provided no financial or intellectual contribution to this work). For the remaining authors, none were declared.

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