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The Impact of Obesity on COVID-19 Outcomes in a High-Risk, Majority Hispanic Community Sample

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ABSTRACT

The novel coronavirus disease 2019 (COVID-19) pandemic has caused over 33.7 million cases and 605,000 deaths in the United States[1]. Factors associated with increased odds for hospitalization, death, and other poor outcomes include age, comorbid conditions like cardiovascular disease and lung disease, and obesity. COVID-19 has also disproportionately affected Hispanic communities across the United States and in Omaha. Potential explanations for this disparity include social determinants of health, particularly occupational factors, structural challenges to access healthcare services, and increased medical comorbidities including obesity. In this retrospective cohort study, we used patient data from April to May 2020 (N=1,000) from a Federally Qualified Health Center with a heavily underserved and Hispanic patient base to examine whether obesity predicted COVID-19 related ER usage and hospitalization, controlling for relevant demographic factors, comorbidities, and social determinants of health. Our adjusted analyses found age and BMI categories as independent predictors of ER usage and hospitalization. These results are important for delineating communities and groups at increased odds for negative COVID-19 outcomes and should play a role in equitable resource allocation.

INTRODUCTION

Novel coronavirus disease 2019 (COVID-19) is an illness caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Since the first detection of the virus in December 2019 in Wuhan, China, it spread quickly and developed into a global pandemic. 219 countries and territories have confirmed cases of COVID-19 with over 184 million cases and nearly 4 million deaths reported. Due to incomplete detection of the disease, particularly in countries with less developed laboratory testing and reporting systems, the actual toll is likely quite higher. In the United States, as of July 2021, the cumulative reported numbers are 34.0 million cases and 608,000 deaths[1]. Furthermore, from March 2020-February 2021 in the United States, 574,000 more people died than in a typical year, which is 21% higher than usually observed and over 50% higher than the reported death toll from COVID-19 over that timespan[2].

SARS-CoV-2 is mainly transmitted by respiratory droplets and close contact with infected individuals. The indolence of COVID-19 has been particularly challenging for public health officials since the majority of individuals are asymptomatic or present mild symptoms. However, symptoms can range from a self-limiting, mild flu-like illness with cough, sore throat and body aches to pneumonia, acute respiratory distress syndrome, and death. Disease severity of COVID-19 is strongly associated with underlying host conditions, particularly advanced age. A patient's overall health and the presence of pre-existing conditions have also been noted to affect susceptibility and the outcome of symptomatic infections.

People with underlying uncontrolled medical conditions, those with lung, liver, and kidney disease, cancer patients on chemotherapy, smokers, and patients on chronic immunosuppressants including steroids are at increased risk of poor outcomes from COVID-19 infection.[3] Meta-analyses tracking the comorbidities of patients hospitalized with COVID-19

have found conditions like diabetes, cardiovascular disease, hypertension, and renal disease are present at numbers greater than their societal prevalence and increase the risk of severe symptoms in hospitalized patients over two fold[4,5]. In terms of odds ratios, cardiovascular disease and chronic respiratory disease have the highest odds of mortality (12.83 and 7.79 respectively)[6]. Obesity in itself, irrespective of other comorbid conditions, has also been identified as a risk factor for severe disease and mortality[7,8]. An analysis of 6.9 million adults in England found the risk of hospitalization was 5% higher for each unit increase in BMI above 23 and the risk for ICU admission was 10% higher for each unit increase. Younger hospitalized patients are especially likely to have comorbidities. Early CDC data found 34.6% of hospitalized patients under the age of 50 had an underlying chronic lung disease[3].

In addition to those with pre-existing conditions, the COVID-19 pandemic has been particularly devastating for minority populations. Case, hospitalization, and death rates in the African American, Native American, and Latino communities are higher than those for White, Non-Hispanic persons in the United States[9]. In Nebraska, among results with ethnicity reported, both COVID-19 cases and hospitalizations are twice as high in Hispanic people as Non-Hispanic people and the death rate is 1.07 times higher despite a younger populous[10]. Locally in Douglas County, 22.3% of COVID-19 cases come from Hispanic people, who make up only 13.4% of the population[11]. While only 11.3% of COVID-19 deaths in Douglas County are among Hispanic people, the average age of death is 65.9 years, significantly lower than the average age of death of 77 years for all persons and lowest among any ethnic group[11]. These mirror national trends where the COVID-19 case and mortality rates for the Hispanic population are the largest among working-age groups and suggest occupational exposure plays a critical role in increasing vulnerability for COVID-19 mortality[12]. The mechanisms of these disparities remain an

opportunity for further inquiry, and like other health differences in health across racial and ethnic groups, conceivably both biomedical factors and social determinants of health are involved[13].

Healthy People 2030 defines social determinants of health as "the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks."[14]. In the United States, social determinants of health can help explain the substantial gender, racial, and ethnic disparities present in health today[15]. Social determinants of health including socioeconomic status, occupation, housing status, access to health care, and race and ethnicity can all effect COVID-19 outcomes. With lack of effective treatment, preventative physical distancing measures have been a mainstay of preventing the spread of COVID-19, but not all populations may be able to successfully distance. An April 2020 New York Times analysis of smartphone location data found people in wealthier neighborhoods were able to reduce their movement sooner than those in poorer neighborhoods and were able to reduce their overall movement by a greater factor. Differences in movement among different income levels were especially increased during the workweek, echoing the suggestion suggested that people in lower-income, often "essential" front-line jobs with face-to-face work continue movement out of economic necessity [16]. Furthermore, the disparities in movement are not just economic: less than one in five Black workers and one in six Hispanic workers are able to work from home, compared to 30% of non-Hispanic White workers[17]. These results are confirmed by a study that found people of color were more likely to be employed in "essential" industries with higher exposure to infections[18].

Aside from occupational risk, when controlling for age minority groups are more likely to be affected by the aforementioned chronic medical diseases increasing risk for symptomatic and severe disease. Minority groups are also more likely to have difficulty accessing care, use

preventative health measures at lower rates, and are more likely to live and work in neighborhoods conducive to unhealthy lifestyles, particularly involving tobacco use, food deserts, and occupational exposures[19]. Minority groups, including Hispanics, have received smaller shares of COVID-19 vaccinations compared to their share of cases and compared to their share of the total population. This discrepancy has been attributed to access, rather than vaccine hesitancy: surveys have found that among the unvaccinated, Hispanics report wanting the vaccine at rates twice that of unvaccinated white and Black adults[20].

Clearly, there exists previous research on both how social determinants of health, obesity, and other pre-existing conditions have impacted COVID-19 severity and mortality, but so far there is little distinction on how they interact together as comorbidities. Additionally, the majority of studies on obesity and pre-existing conditions affecting COVID-19 outcomes have taken place among hospitalized patients. An April 2021 literature review found only one study focusing on the effects of obesity and comorbid conditions on COVID-19 in an outpatient population[8]. Our study can add to the literature and inform practice by focusing an underserved, minority population in an urban outpatient setting in a Midwest Federally Qualified Health Center. Our patient population is high risk - the majority of our patient population is Hispanic, uninsured, and 93% live below 200% of the poverty line. The primary aim of our study is to measure the impact of obesity on COVID-19 outcomes in a majority Hispanic population at increased risk due to social determinants of health. Our results are of interest to public health practitioners, primary care physicians, and clinicians who have similar populations at high risk for poor COVID-19 outcomes.

The project aims to answer the following research questions:

1. Among patients who test positive for COVID-19 in an outpatient setting, does obesity predict COVID-19 related emergency room (ER) usage?
2. Among patients who test positive for COVID-19 in an outpatient setting, does obesity predict COVID-19 related hospitalization?

Our specific research aims are related to larger goals in the field of public health. We must understand how SARS-CoV-2 interacts with other medical conditions since there will likely be further outbreaks of similar respiratory viruses, if not SARS-CoV-2 variants. We are still unaware of how long immunity with vaccinations will last and identifying high risk populations is a priority. Additionally, there is a large component of social justice in this study. Before we can reduce racial, ethnic, economic, and other health disparities, we must first identify and recognize their existence. Quantifying these disparities allows us to assess their magnitude and track our progress as we attempt to reduce disparities. It is important we have data on our underrepresented populations so we ensure we can best serve people from all walks of life.

METHODS

Study Setting

OneWorld Community Health Centers is a Federally Qualified Health Center with twelve clinics in three counties throughout the Omaha metro area. Over the last year OneWorld Community Health Centers served 50,182 individuals. The clinic cares for patients regardless of their ability to pay with over 51% of patients lacking medical insurance[21]. Furthermore, over 65% of OneWorld patients speak a language other than English as their primary language, with the most common primary language being Spanish. Through its commitment to cultural competence, treatment of the underserved, outreach to refugee communities, and a bilingual

medical staff, OneWorld has developed a diverse patient base that is primarily Latino and Spanish-speaking.

Towards the onset of the COVID-19 pandemic, OneWorld uncovered many of the initial cases in Nebraska from patients working in meatpacking plants and other large industrial facilities. Along with partnerships through the National Guard, Douglas County Health Department, and Nebraska Medicine, OneWorld began operating free COVID PCR testing sites in South Omaha. As of April 2021, OneWorld had administered a cumulative 14,723 COVID tests with a 32% case positivity rate. All patients who underwent testing had electronic medical records created for their results and contact tracers gathered information on symptoms, exposures, prior medical conditions, and household size. Further information regarding outcomes is available thanks to medical record review of case management and patient follow-up.

Study Design

To evaluate the effects of increased BMI on COVID outcomes, we conducted a retrospective cohort study beginning with all patients who had been diagnosed with COVID-19 based on positive laboratory test results at a OneWorld testing site or with diagnostic codes indicating a diagnosis of COVID-19 in the OneWorld electronic medical record system from March to May 2020. Our sample was restricted to non-pregnant patients who were at least 18 years old, had a previous medical visit at OneWorld prior to their COVID-19 test, and had BMI data available within the two years prior or six months following their COVID-19 diagnosis. Electronic medical records provided access to subject data for BMI, diagnostic history, demographic characteristics, social determinants of health, and COVID-19 outcomes. The institutional review board approved the exempt study and waiver of consent.

Measures

BMI: The BMI measurement at the date of diagnosis or the value closest to that date was selected. Body mass index was calculated by kilograms (kg)/meters $(m)^2$. The World Health Organization (WHO) categories for overweight and obesity were used[22].

Comorbidities: Clinical risk factors followed included tobacco use and diagnoses of asthma, cerebrovascular disease, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), diabetes mellitus, hypertension, dyslipidemia, malignancy, coronary artery disease (CAD), organ transplant status, peripheral vascular disease (PVD), and renal disease. Comorbidities were tracked by the presence of an ICD-10 code in the electronic medical records or patient affirmation of comorbid conditions when informed of their COVID-19 diagnosis.

Demographic Characteristics: Demographic factors including race/ethnicity, sex, age, household size, and preferred language were tracked. Factors were obtained directly from electronic medical records.

Social Determinants of Health: We considered social determinants of health including insurance status, zip code, and whether the patient worked in an industry at high risk for COVID. Insurance status and zip code were obtained from each patient's billing information. Occupation was obtained from interviews with the patients conducted while informing of their COVID-19 diagnosis. Industries considered high risk included meatpacking, healthcare, and residential assisted living facilities.

COVID-19 Outcomes

Outcomes tracked included ER visits, hospitalizations, and death directly related to COVID-19 infection. Outcomes were gathered from notes in the patient medical records and the Nebraska Health Information Initiative, a statewide exchange for clinical data.

Data Analysis

We controlled for other chronic diseases that have been associated with increased risk of severe COVID infection. Data was additionally controlled for age, gender, race and ethnicity and income level. Week of diagnosis was included as a covariate to adjust for changes in testing practices, social distancing recommendations, and potential changes in clinical management throughout the study period. Since the frequency of death was so low in our sample, analyses were only conducted for ER visits and hospital admissions.

Each covariate and outcome were assessed in a series of bivariate analyses, comparing those who visited the ER, were hospitalized, or died using a Chi-Squared analysis or Fisher exact test depending on expected count. All independent variables that were statistically significant at the $p < 0.05$ level were included in the adjusted analysis. Adjusted odds ratios for each outcome tracked were generated for different BMI categories and selected social determinants of health using multivariable logistic regression[8]. All analyses were done using SPSS statistical software version 27.0.

RESULTS

We identified 1,000 patients with COVID-19 diagnoses on dates ranging from 04/02/2020-05/22/2020. Cases were identified by a positive result on polymerase chain reaction testing performed by OneWorld Community Health Centers or the Nebraska National Guard. Of these 1,000 patients, 538 fit inclusion criteria. Overall, the majority of patients in our sample were White (92.6%), Hispanic (94.4%), and Spanish-speaking (84.0%) (Table 1). Our sample had a slight female preponderance (58%). At our index date, the mean age was 40.6 years (SD=13.4), and the mean BMI was 30.83 (SD=6.53). On average, BMIs were taken 171.9 days apart from the date of diagnosis. Our sample was primarily uninsured (58.4%), and a large percentage were employed in a high-risk occupation (37.9%). The most prevalent comorbidities were dyslipidemia (23.8%),

diabetes mellitus (18.2%), hypertension (15.6%), asthma (4.8%), and renal disease (4.6%). A total of 57 (10.6%) patients from our sample visited the ER, 31 (5.8%) were admitted to a hospital, and 5 (0.9%) died.

We detected a statistically significant interaction between categorical BMI and categorical age ($p < 0.001$) and between categorical BMI and sex ($p = 0.029$). Analyses comparing week of diagnosis to each outcome found no significant results ($p = 0.649$, 0.853 for ER visits and hospital admissions respectively). When age was stratified into ten-year age categories, significant associations were found with both ER visits and hospital admissions. Aside from age, no significant associations were detected between demographic characteristics and social determinants of health aside from an association between payer and the odds of hospitalization. The covariates selected for our adjusted models were those present in more than ten individual patients showing significant associations using the Chi-square or Fisher exact tests for each outcome.

Adjusted Analysis for ER visits

For ER visits, covariates included: age category, BMI category (WHO), diabetes mellitus, hypertension, dyslipidemia, and renal disease (Table 2). We noted significant associations between age category and ER visits, but not with BMI category and ER visits or our selected comorbidities. In adjusted analyses, an underweight BMI was associated with higher odds for ER visits, while increasing BMI category above overweight showed increased odds of an ER visit as well.

Adjusted Analysis for Hospitalizations

For hospitalizations, covariates included: age category, BMI categories (WHO), payer status, diabetes mellitus, dyslipidemia, hypertension, and renal disease. Significant associations were noted between both age and BMI categories with hospitalizations. Differences between BMI

categories were pronounced, with BMI categories between Normal and Obese Class II showing significantly lower odds for hospitalization than Obese Class III.

DISCUSSION

Overall, our sample reported similar rates of hospitalization and lower death rates than were present in the state of Nebraska at large at the end of our study period (5.8% and 1.2% of those tested in the same period respectively)[23]. Our average age was lower than the average age of all adults testing positive for COVID-19 in Douglas County during the time frame of our study with notably fewer patients over the age of 70, the population at highest risk for hospitalization and mortality[11]. ER visits due to COVID-19 have not been tracked on a national or local scale and are a more subjective endpoint than hospitalizations or death rates. All patients in the study were contacted by medical staff at OneWorld for triage of symptoms at intervals judged appropriate with a COVID Severity rating scale. Patients with concerning symptoms would be frequently referred to an urgent triage visit at OneWorld or advised to report to the ER. While not all patients followed these guidelines, the application of objective criteria guiding ER recommendations makes it a more measurable endpoint for tracking.

The associations we found between BMI and the odds for ER visits and hospitalizations show that BMI is an independent risk factor for negative outcomes associated with COVID-19 diagnosis in our primarily Hispanic and uninsured patient sample. These associations were independent of obesity-related comorbidities and potential confounders. Importantly, the odds for negative outcomes increased with ascending BMI categories. Medical comorbidities frequently associated with obesity in metabolic syndrome like diabetes mellitus, dyslipidemia, hypertension, and renal disease all showed initial associations with negative outcomes, but when adjusted for other factors with logistic regression did not show significance. While the

Underweight BMI category showed increased odds for both ER visits and hospitalization, the adjusted odds were not significant at a 95% confidence interval, likely due to the low count of underweight patients in our sample.

With the relative rarity of negative events associated with COVID-19, it is possible our sample size was not large enough to elucidate associations found between demographic characteristics, social determinants of health, and medical comorbidities seen in other studies. Significant associations between COPD, CAD, congestive heart failure, and peripheral vascular disease and negative COVID-19 outcomes were detected, but because few patients in our sample reported these comorbid conditions they were not included in our adjusted analyses. Other conditions like cerebrovascular disease, malignancy, and organ transplant were found at too low of rates in our population to draw conclusions. While asthma was present, the younger average age of the patients diagnosed with asthma in our sample likely played a role in the rarity of negative events associated with asthma.

As a whole our patient population had an increased prevalence of some comorbidities with obesity and diabetes mellitus rates higher than the surrounding metro area (48.1% and 18.2% vs 33.5% and 11.2% respectively)[24]. Other comorbidities in our sample including heart disease, cerebrovascular disease, cancer, and COPD appeared at rates much lower than the surrounding community, possibly reflecting the relatively young average age of our sample. Self-reported tobacco use is much lower than is reported in the surrounding population[24]. There also exists the possibility that selection bias has occurred in the form of our study population's high rates of manual labor work. The vast majority of patients categorized as high-risk worked in meat packing facilities, which require physical strength and stamina. Though these conditions leave patients at increased risk for acute injuries and long-term health problems, a person cannot

perform the job without the capacity for physical exertion which is protective against respiratory diseases. Finally, it is possible these comorbidities are present, but undiagnosed in our patient population who through lack of insurance does not always have access to diagnostic testing. As seen in the lengthy average time since patients had BMI measurements taken, many of the patients in our sample do not frequently access healthcare.

Though we did not find significant adjusted effects for our demographic characteristics or social determinants of health, this does not mean they have not played a role in our outcomes. We attribute or lack of demographic significance to a lack of diversity in our heavily White, Hispanic, Spanish-speaking patient population and the lack of large comparison groups in other ethnic or racial categories. While mortality was too rare of an event in our sample to adequately track associations, comparing the outcomes of our primarily Spanish-speaking population with the population at large may yield disparities since the primary public testing organization in Nebraska initially lacked Spanish speaking staff. A larger sample size would provide greater power to uncover associations between social determinants of health and outcomes we believe are currently masked. While our sample size is somewhat large, the outcomes we tracked, especially death, were exceedingly rare and a larger sample size would likely provide a clearer picture. It is our hope that further analysis using more of OneWorld's COVID-19 database will be able to provide a more granular look into risk factors for poor COVID-19 outcomes from both a medical lens and with social determinants of health.

CONCLUSION

In summary, our study contributes to the general understanding of obesity's effects on adverse COVID-19-associated outcomes. Our results agreed with other studies that determined obesity was an independent risk factor for poor COVID-19 outcomes. We have evidence that our

sample, though younger, suffered similar rates of hospitalization as the community as the community at large. Obesity, especially morbid obesity, independently increased the odds for negative outcomes in our population, explaining at least some of this disparity. Many of the same social determinants of health putting our population at higher risk for obesity have been found to independently increase the risk for negative COVID-19 outcomes as well. As we move forward promoting vaccinations as the best defense against COVID-19 infection and poor outcomes, it is important to use this knowledge to better target communities and groups at high risk for poor COVID-19 outcomes so that we ensure equitable distribution of resources.

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