



Early COVID-19 Vaccine Hesitancy Characteristics in Mothers Following Bariatric Surgery

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Received: 13 August 2021 / Revised: 24 December 2021 / Accepted: 29 December 2021 / Published online: 8 January 2022
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Abstract

Background Obesity has played a central role in heightened coronavirus disease 2019 (COVID-19) risk and vaccine response. COVID-19 vaccine intention among those with a history of severe obesity, specifically those who have undergone bariatric surgery, has not been described. This study aims to examine early COVID-19 vaccine intention among mothers with a history of severe obesity who underwent bariatric surgery.

Methods Sixty-four mothers ($M_{age} = 39.3$ years) who underwent bariatric surgery ($M_{time\ since\ surgery} = 19.6$ months) completed surveys online (November 2020–February 2021). Information obtained included their COVID-19 vaccine intention (vaccine ready, undecided, vaccine opposed). Analyses examined group differences in demographics, body mass index (BMI = kg/m²), knowledge of obesity-related COVID-19 risk, flu vaccination history, general beliefs about vaccine safety/effectiveness, and factors increasing confidence/motivation to obtain a COVID-19 vaccine.

Results Thirty-six (56.3%) mothers had severe obesity (\geq Class II [BMI = ≥ 35 kg/m²]). The majority were vaccine hesitant (undecided [$n = 28$; 43.8%]; vaccine opposed [$n = 15$; 23.4%]). Compared to the vaccine-ready group, vaccine-hesitant groups were younger ($p < .05$). For the vaccine opposed, recent flu vaccination rates ($p = .012$) and general belief that vaccines are safe ($p = .028$) were lower than expected. Among hesitant participants, no reported side effects and the health of self and others were endorsed as top factors increasing vaccine confidence and motivation respectively.

Conclusions While preliminary, the prominence of early vaccine hesitancy in this sample of mothers who have undergone bariatric surgery, with most persisting with severe obesity, indicates a subgroup at high risk. Factors to address through targeted messaging and intervention were identified.

Keyword COVID-19; Obesity; Bariatric surgery; Vaccine hesitancy

Key points

- Single-center data showed COVID-19 vaccine hesitancy in 67% of mothers post-surgery
- Most still had obesity, yet a third were unaware of the obesity risk for COVID-19
- Age, recent flu vaccine, and vaccine safety beliefs were related to hesitancy
- Expert input, understanding side effects, and health benefits may be key

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Introduction

Obesity and related comorbid health conditions have played a central role in coronavirus disease 2019 (COVID-19) risk and response. Individuals with obesity are at heightened risk for experiencing more severe COVID-19 illness, hospitalizations, and progression to intensive care, as well as COVID-19 related death. [1, 2] Moreover, those with obesity who recover from the primary COVID-19 infection are also more likely to experience post-acute sequelae of COVID-19 (i.e., “long COVID”) compared to individuals with a healthy body mass index (BMI = kg/m²). [3] As such, in the United States (U.S.), initial vaccine distribution plans in many states prioritized individuals with obesity and/or related comorbidities for early vaccine access. [1, 4]

Encouraging evidence suggests that for those with severe obesity, undergoing bariatric surgery may reduce

COVID-19 morbidity and mortality [5–10]. However, even with improved weight and health following bariatric surgery, many individuals may continue to present with known risk factors for severe COVID-19 (i.e., high BMI [kg/m²], unremitting Type 2 Diabetes). For example, insufficient weight loss or weight regain may result in a post-surgical BMI (kg/m²) that remains in the obese or severely obese range. [11] Understanding the interplay of surgical outcomes and COVID-19 outcomes is a critically important and emerging literature. However, even if individuals experience improved COVID-19 outcomes in connection with a history of bariatric surgery, undoubtedly surgery does not prevent risk of virus transmission. Thus, from a public health perspective, it is also imperative to understand patient COVID-19 vaccine intentions.

Widespread vaccine uptake has been essential in reducing COVID-19 related morbidity and mortality, but also in slowing transmission of the virus and the potential emergence of more life-threatening variants. [12] Yet less is known about vaccine intention in people with obesity, [13, 14] and specifically those who have undergone bariatric surgery. Research conducted in the general population, prior to the U.S. vaccine rollout in December 2020, [15] suggested that demographic differences, such as being female, younger, lower educational attainment, or belonging to certain ethnic minority groups were associated with greater vaccine hesitancy. [16–18] Individual attitudes and beliefs, including hesitancy about vaccines in general, uncertainty about COVID-19 vaccine safety, and apprehension due to COVID-19 vaccine novelty have also been identified as factors associated with lower vaccine intention. [18–20] Similar apprehensive attitudes were observed in the only published study to date, on COVID-19 vaccine attitudes among a sample with obesity. [14] In June to October 2020, researchers surveyed adults with obesity in Canada and found that approximately 40% were vaccine hesitant and many had low confidence in a COVID-19 vaccine.

At the time data were collected for the current study (November 2020–February 2021), national surveillance estimated that approximately half of the people in the U.S. either had (18%) or were intending (37%) to be vaccinated. [19] Also during this time, COVID-19 daily rates in the state where most study participants lived reached the highest peak to date, with 12,973 new cases — and 209 deaths — in a day. [21, 22] Within this dynamic context, the present study aims were to examine early COVID-19 vaccine intention among a sample of women with a history of bariatric surgery. Given larger study aims, women were also mothers with children 18 years or younger under her care. Study aims also included exploration of whether early vaccine intention varied by demographic factors, BMI (kg/m²) and knowledge of obesity as a risk for severe COVID-19, as well as general vaccine beliefs and recent flu vaccine history (used

as a proxy of general vaccine acceptance). [23] Factors that would increase their confidence and motivation to obtain the COVID-19 vaccine were explored. Understanding early vaccine intention and related factors for an at-risk sample is important in order to highlight potential areas of focus for improving COVID-19 vaccine uptake. Given the unprecedented nature of this global pandemic, current findings will also help expand the field's knowledge of vaccine beliefs and intentions in the context of a pandemic, which has implications for informing approaches to future large-scale disease outbreaks.

Methods

The present study uses data obtained from the Maternal Attitudes Surrounding COVID-19 (MASC) study, the aims of which were to better understand mothers' perceptions of the impact and experiences related to COVID-19 on families with obesity. The 4-month MASC recruitment window (November 2020 to February 2021) fell during the launch of the COVID-19 vaccine distribution in the U.S. yet prior to BMI (kg/m²) or obesity being prioritized for vaccine access locally. The present study focuses on a MASC study subgroup of mothers who had undergone bariatric surgery and were recruited from a research registry of bariatric surgery candidates at a single clinical center, willing to be contacted for future research ($n = 452$, registry enrollment June 2016–September 2019). MASC study eligibility required mothers to have a biological child ≤ 18 years living in the home, access to the internet and a smart device/computer, and the ability to read and speak English fluently. All women on the registry were sent an email and/or text message introducing the study. During the MASC study window, 98 mothers from the registry consented, and 94 proceeded to participate, of whom 64 had undergone bariatric surgery since enrolling in the registry.

Following completion of the informed consent process, mothers were emailed a unique study link to complete questions online via Research Electronic Data Capture (REDCap)TM. [24, 25] A subset of MASC study questions focused on vaccine intention, attitudes, and beliefs were designed by the investigators and informed by the broader literature on general vaccine acceptance, intentions, and behaviors. [23, 26] COVID-19 vaccine intention groupings were based on 3 response options: vaccine ready (“get it as soon as possible”), undecided (“wait and see how others respond to the vaccine first and then maybe get it”), and vaccine opposed (“not get the vaccine”). Participants also reported their history of COVID-19 symptoms or diagnosis (yes/no), knowledge of obesity as a risk factor for severe COVID-19 (yes/no), flu vaccination history in the past 12 months (yes/no), general beliefs (i.e., not COVID-19 specific) regarding

Table 1 Knowledge, attitudes, beliefs, and vaccine intention survey questions

Questions	Response Options
1. Someone in the family had symptoms or was diagnosed with COVID-19	yes, no
2. Prior to today, were you aware that the CDC lists obesity as a risk factor for severe illness from COVID-19	yes I did know, no I did not know
Attitudes and Beliefs about Vaccines in General	
3. In general, I believe the use of vaccines is a safe way to protect against illnesses	strongly agree, agree, disagree, strongly disagree
4. In general, I believe vaccines are effective in protecting against illnesses	strongly agree, agree, disagree, strongly disagree
5. Did you get a flu vaccine in the past 12 months?	yes, no
Attitudes, Beliefs, and Intentions COVID-19 Vaccine	
6. If a COVID-19 vaccine was made available to you, would you...	get it as soon as possible wait to see how others respond to the vaccine first then maybe get it not get the vaccine
7. What would make you more confident about the safety and effectiveness of a COVID-19 vaccine? (check all that apply)	if my doctor recommended it for me if it is recommended by national health experts or organizations (e.g., CDC, health department) if national or local government officials recommend it If my friends or family members get the vaccine if there are no reports of negative side effects after others begin getting the vaccine nothing would make me confident about the safety and effectiveness of the COVID-19 vaccine other-explain
8. What are some things that would motivate you to get the COVID-19 vaccine? (check all that apply)	if my job requires me to get the vaccine I have a child or older family member living in my home I or someone in my home has a compromised immune system or chronic health condition if it is widely available and convenient nothing would motivate me to get the COVID-19 vaccine other explain

vaccine safety and effectiveness (strongly agree/agree/disagree/strongly disagree), as well as factors that would increase confidence and motivation to obtain a COVID-19 vaccine. Questions from this 8-item survey on beliefs, intention, knowledge, and virus exposure are shown in Table 1. Additional self-reported information included demographics (race/ethnicity, education, partnership status, age, number of children in the home), height and weight (BMI = kg/m²), and bariatric surgery date (used to calculate time since surgery). Participants were compensated \$10. This study was approved by the Cincinnati Children's Hospital Medical Center Institutional Review Board.

Descriptive statistics were used to summarize data. Given our interest in all three vaccine intention groups (vaccine ready, undecided, vaccine opposed) and small sample sizes, univariate analyses were completed. To explore relationships between vaccine intention groups and variables of interest, one-way analyses of variance (ANOVA) and Pearson's χ^2 tests were conducted for continuous and categorical

variables, respectively, with post hoc analyses completed for significant ($p < 0.05$ [2-tailed]) omnibus tests. Tukey's honestly significant difference (HSD) examined all pairwise comparisons in ANOVAs. For χ^2 tests, adjusted standardized residuals were used [27] with the Benjamini–Hochberg adjustment method applied to control for familywise Type 1 error. [28] There were no missing data for variables included in the analyses. All analyses were conducted using IBM SPSS Statistics software (version 26; Armonk, NY).

Results

Table 2 details sample characteristics and all outcomes of interest for the total sample, and by vaccine intention group. Consistent with national data characterizing adults undergoing bariatric surgery, [29] self-reported race and ethnicity were primarily White/European (61.9%) and non-Hispanic/Latinx (98.4%). Women were approximately 39 years of

Table 2 Sample characteristics, knowledge of obesity risk for COVID-19, history of flu vaccination, and general vaccine beliefs by COVID-19 vaccine intention group

	All	Vaccine ready	Undecided	Vaccine opposed	F/χ^2 ^a	p
Female, N (%)	64 (100)	21 (32.8)	28 (43.8)	15 (23.4)	N/A	
Age (years), M (SD)	39.3 (6)	42.6 (6.2)	38.4 (5)	36.4 (5.6)	6.08	.004
Race ($N=63$), n (%) ^b					3.03	.22
White/European	39 (60.9)	15 (71.4)	18 (64.3)	6 (40)		
Black/African American	20 (31.2)	4 (19.0)	9 (32.1)	7 (46.7)		
Asian/Asian American	1 (1.6)	1 (4.8)	0	0		
Bi-racial/Multi-racial	3 (4.7)	1 (4.8)	1 (3.6)	1 (6.6)		
Unknown/Not reported	1 (1.6)			1 (6.6)		
Ethnicity ($N=61$), n (%)					N/A	
Hispanic/Latinx	1 (1.6)	0	1 (3.6)	0		
Partnership Status, n (%)					6.45	.04
Single/Unmarried	22 (34.4)	3 (14.3)	11 (39.3)	8 (53.3)		
Living with partner/Married	42 (65.6)	18 (85.7)	17 (60.7)	7 (46.7)		
Number of children (≤ 18 years) in home, M (SD)	2.3 (1.3)	1.9 (.7)	2.4 (1.4)	2.5 (1.6)	1.15	.32
Highest Education, n (%)					3.66	.45
\leq High School Diploma/GED	22 (34.4)	7 (33.3)	9 (32.1)	6 (40)		
Undergraduate degree/Vocational training	27 (42.2)	7 (33.3)	15 (53.6)	5 (33.3)		
Graduate-/Professional degree	15 (23.4)	7 (33.3)	4 (14.3)	4 (26.7)		
BMI (kg/m^2), M (SD)	36.9 (8.1)	36 (7.3)	37 (8.5)	38.1 (8.7)	.29	.75
Healthy weight ^c , n (%)	2 (3.1)	2 (9.5)	0	0		
Overweight ^c , n (%)	11 (17.2)	2 (9.5)	6 (21.4)	3 (20)		
Obesity class I ^c , n (%)	15 (23.4)	6 (28.6)	7 (25)	2 (13.3)		
Obesity class \geq II ^c , n (%)	36 (56.3)	11 (52.4)	15 (53.6)	10 (66.7)		
History of COVID-19 diagnosis or symptoms ^d , n (%)	12 (18.8)	7 (33.3)	2 (7.1)	3 (20)	N/A	
Had knowledge of obesity as a risk for COVID-19 ^d , n (%)	41 (64.1)	14 (66.7)	17 (60.7)	10 (66.7)	.24	.89
Received flu vaccine (past 12 months) ^e , n (%)	39 (60.9)	17 (81)	17 (60.7)	5 (33.3)	8.34	.02
General belief vaccines are safe ^e , n (%)	51 (79.7)	20 (95.2)	23 (82.1)	8 (53.3)	9.68	.01
General belief vaccines are effective ^e , n (%)	56 (87.5)	20 (95.2)	25 (89.3)	11 (73.3)	3.98	.14

^aChi-square tests (χ^2) were completed for percentages and ANOVAs (F) were completed for mean values to test differences among vaccine intention groups ($df=2$)

^bDichotomized as White/European vs Non-White/European for chi-square analysis

^cBMI categorized as healthy weight at $18.5 < \text{kg}/\text{m}^2$, overweight at $25 < \text{kg}/\text{m}^2$, obesity class I at $30 < \text{kg}/\text{m}^2$, obesity class II at $\geq 35 \text{ kg}/\text{m}^2$

^dNumber of participants who responded “yes”; variable represented in analysis as “yes” and “no”

^eNumber of participants who responded, “strongly agree” or “agree”; variable dichotomized in analysis as “strongly agree”/ “agree” and “strongly disagree”/ “disagree”

age (range 25.9–54.7 years), with most residing with a partner (65.6%) and 2 biological children ≤ 18 years (range 1–6 children) and having completed post-secondary education/training (65.6%). Mean time since bariatric surgery was 19.6 months ($SD = 10.9$; range < 1 month–47 months) with the majority of mothers meeting criteria for obesity (79.7% \geq Class I [BMI = $\geq 30 \text{ kg}/\text{m}^2$]) if not severe obesity (56.3% \geq Class II [BMI = $\geq 35 \text{ kg}/\text{m}^2$]). Nearly 1 in 5 reported a previous diagnosis or symptoms of COVID-19.

Approximately 1 in 3 women were in the vaccine-ready group, ($n=21$; 32.8%), with the majority either in the undecided

($n=28$; 43.8%) or vaccine-opposed ($n=15$; 23.4%) group (Fig. 1). Vaccine intention significantly varied between groups based on age ($p=0.004$), with the undecided and vaccine-opposed groups being significantly younger (undecided $p=0.03$; vaccine opposed $p=0.01$) relative to the vaccine-ready group. Vaccine intention was significantly associated with partnership status ($p=0.04$), with higher than expected rates of married/residing partner participants in the vaccine-ready group ($p=0.02$). Vaccine intention was unrelated to race (defined as White/European vs. Other racial/ethnic groups), education, number of children in the home, or current BMI (kg/m^2).

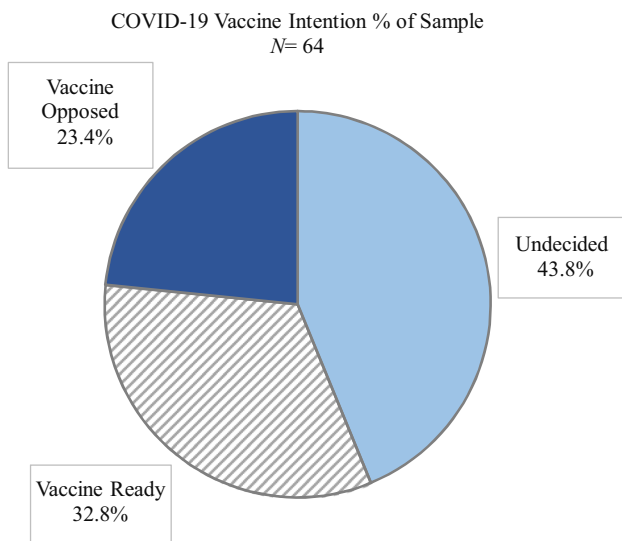


Fig. 1 Vaccine intention group based on response to item: “If a COVID-19 vaccine was made available to you would you... get it as soon as possible (vaccine ready), wait and see how others respond to vaccine and then maybe get it (undecided), or not get the vaccine (not vaccine opposed).”

COVID-19 vaccine intention was associated with a general belief that vaccines are safe ($p = 0.008$) and obtaining a flu vaccine in the past 12 months ($p = 0.02$), but unrelated to a general belief that vaccines are effective or to knowledge of obesity increasing risk for severe COVID-19. Post hoc analyses indicated that belief that vaccines are safe was

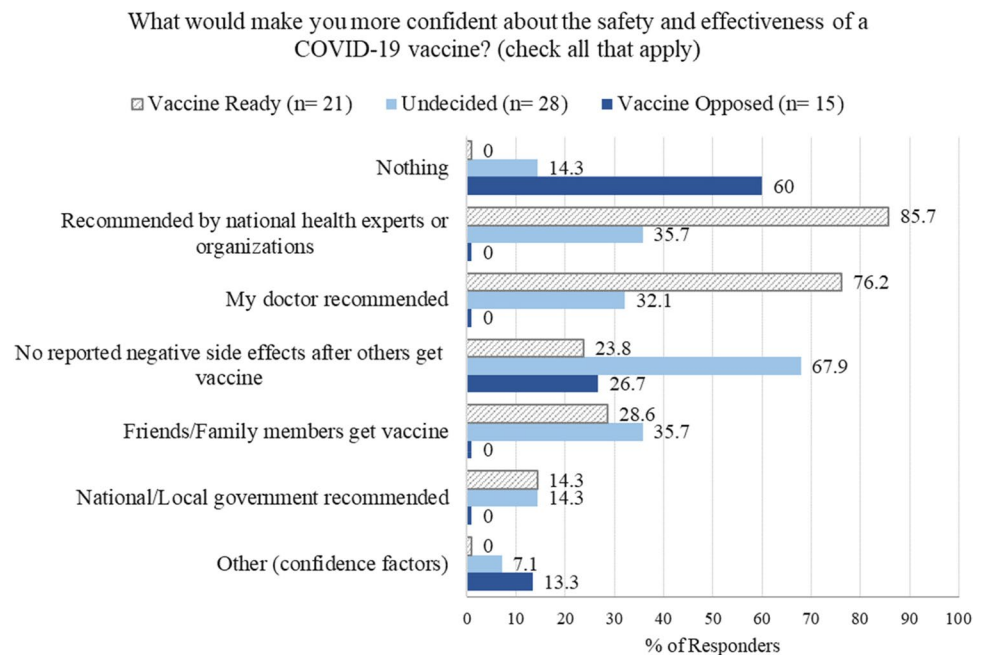
higher than expected in the vaccine-ready group ($p = 0.004$) and lower in the vaccine-opposed group ($p = 0.03$). Similarly, flu vaccination rates were higher than expected in the vaccine-ready group ($p = 0.02$) and lower in the vaccine-opposed group ($p = 0.01$).

The vaccine-ready and undecided groups endorsed multiple factors that would increase their confidence in COVID-19 vaccine safety and effectiveness, including clinician and other health expert recommendations, and for the undecided group, reports of no side effects were also important (Fig. 2). For the vaccine-ready and undecided groups, motivating factors to get a COVID-19 vaccine included an employer mandate or a compromised immune system for self or others in the home (Fig. 3). In stark contrast, the majority of the vaccine-opposed group reported “nothing” would increase their confidence or motivate them to obtain a COVID-19 vaccine.

Discussion

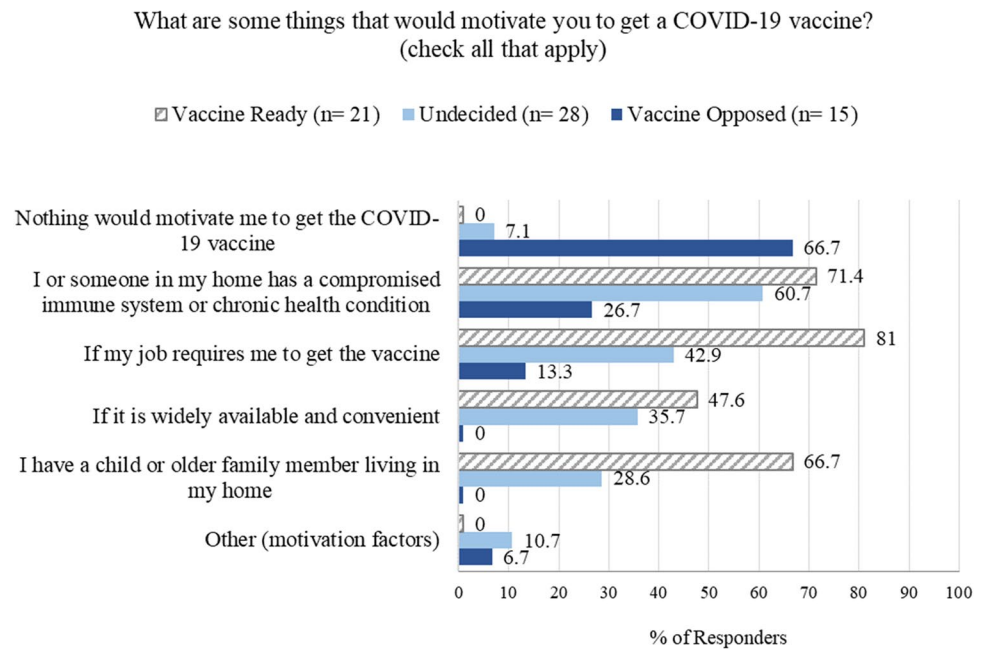
While preliminary, these data provide an early snapshot of prominent vaccine hesitancy in a clinical sample of mothers post-bariatric surgery during the peak of new COVID-19 cases and deaths both locally and nationally, as well as during the initial COVID-19 vaccine distribution phase in the U.S. [15, 21, 22] Two in 3 were unsure (43.8%) or not planning to get the vaccine (23.4%), numbers fairly consistent with national views during the same time period. [19]

Fig. 2 Factors contributing to increased confidence summarized as % endorsed by each vaccine intention group



Other (confidence factors) responses included follow-up qualitative responses [$n = 4$], the theme across groups was a desire to see “long term” data demonstrating no side effects.

Fig. 3 Factors contributing to motivation to get the COVID-19 vaccine summarized as % endorsed by each vaccine intention group



Other (motivation factors) responses included follow-up qualitative responses [$n = 4$], the theme across groups was “no negative side effects” reported.

However, unique to the present sample is not only a post-bariatric surgery context, but a high prevalence of persisting obesity, if not severe obesity. Consistent with national data, [30] the majority had knowledge that their obesity placed them at risk for severe COVID-19 morbidity and mortality. Yet that 1 in 3 (35.9%) still lacked that knowledge during the “third wave” in the United States when the daily number of new cases reached their peak is concerning. Although there is some evidence to suggest bariatric surgery may contribute to reduced morbidity and mortality, the potential protective mechanism of bariatric surgery is not fully understood in individuals who persist with obesity. [5–7, 9, 10] Also of note, despite the positive role that bariatric surgery may have in reducing severe COVID-19 outcomes, it does not protect against virus transmission, which remains a critical public health concern.

At the time of this writing, in the U.S. and locally, rates of COVID-19 vaccinations were < 50%. [22, 31] With the growing spread of the COVID-19 Delta variant, largely among those who are unvaccinated, it has been recommended that individuals return to wearing masks in public, with a concern for a return to increased public restrictions. [21, 32] The present findings illustrate the potential for a clinical subpopulation at continued high risk, as well as highlight factors to tailor COVID-19 vaccine acceptance messaging in bariatric surgery care. Given many acknowledged their trust in recommendations of their medical providers and other health experts, bariatric surgery clinicians may be positioned to have a positive impact on vaccine

uptake for some hesitant patients, including younger, female patients who may be more vaccine hesitant. Knowledge of patients’ recent flu vaccination history may also suggest when targeted discussion about vaccine beliefs would prove timely.

To increase confidence and motivation, clinicians might be primed to explain clinical trial processes and outcomes, including anecdotal experiences of short-term and tolerable side effects. Providing education on how and where to access the vaccine and that it is provided at no cost will also reduce misinformation. Counseling hesitant patients in ways that resonate with their values may prove helpful, noting protective benefits of vaccination for their health and the health of loved ones. Fortunately, bariatric surgery team members have multiple opportunities to engage patients during follow-up across the first post-bariatric surgery year, but clinicians should consider additional means of patient outreach (i.e., mailed newsletters and MyChart messaging) given the likelihood of decreased clinic attendance over time. [33] Moreover, considering these data characterize mothers, there are broader intergenerational implications, as parents typically are vaccine decision-makers for their children. [23] Finally, it is important to acknowledge that some individuals (i.e., vaccine-opposed group) will be particularly difficult to persuade to get a COVID-19 vaccination. As such, continued research and public engagement are important in order to understand the perspective of hard-to-reach populations.

To our knowledge, these are the first data characterizing early COVID-19 vaccine hesitancy within a sample of

patients who underwent bariatric surgery, while also adding to emerging research on vaccine intention among individuals with obesity who are an identified high-risk population. This is particularly timely given the resurgence of COVID-19 hospitalizations due to new disease variants and as indications and parameters for a booster shot are debated. [31, 34] While novel, this study is not without limitations. Due to study design, current data are limited by sample size and in that they are from a single medical center in the Midwestern U.S. and represent only mothers who were reachable during a brief study window (November 2020 to February 2021) during the initial U.S. distribution of a COVID-19 vaccine. Further, the sample only included mothers with residing biological children (≤ 18 years), which may have contributed to a sample younger than the average age of bariatric surgery patients in the U.S. (i.e., 44 years old). [29, 35] Also, because we recruited from an existing patient registry limited to biological mothers, data do not include men, or women without biological children. All these factors may impact the generalizability of the current findings to the broader bariatric surgery population. Though this sample was similar to the larger U.S. bariatric surgery population in that it was predominantly Non-Hispanic/Latinx, White, indeed the sample reflects a systemic disparity in the larger patient population. [29] As such, given the sample's limited racial and ethnic diversity, data may not fully capture the experience of all mothers who have undergone bariatric surgery. In addition, while the majority of study participants (63%) completed surveys during the initial vaccine rollout in the U.S., what has unfolded since has unexpectedly become an ever-changing landscape of COVID-19. As a result, intentions and beliefs may have changed for mothers after study completion. Research is critically needed with larger and more diverse samples (e.g., non-White, lower socioeconomic status, non-English speaking) with obesity to fully capture this evolving crisis and dynamic vaccine hesitancy and uptake trends over time. As recently noted by others, additional work should also consider other potential obesity-specific contributors to COVID-19 vaccine hesitancy, including uncertainty about vaccine effectiveness [13] and the effects of obesity-specific clinical- and public health messaging on experiences of weight bias and stigma and vaccine decision-making. [36]

Conclusions

The current pandemic presents an intersection of two public health crises, COVID-19 and obesity. As the COVID-19 vaccine campaign continues and public health initiatives work to encourage COVID-19 vaccination among those who are hesitant, targeted and specific efforts may be needed to

ensure COVID-19 vaccine uptake in groups with obesity, including those who have undergone bariatric surgery.

Acknowledgements The authors would like to thank the women who participated in this study. We would also like to acknowledge the clinical staff at UC Health Weight Loss Center (Cincinnati, OH): Jon Thompson, MD, and Diana Harris; and additional members of the research team at Cincinnati Children's Hospital Medical Center: Faye Doland, BS, and Kristina Decker, PhD. We would also like to acknowledge the Center for Clinical and Translational Science and Training which provided institutional grant support (2UL1TR001425-05A1) for the REDCap data collection system.

Funding This project and Dr. Strong's effort were supported by a post-doctoral training grant from the National Institutes of Health (NIH), National Institutes of Diabetes and Digestive and Kidney Diseases (T32DK063929-18S1).

Declarations

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare no competing interests.

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Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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