Demographic Characteristics of Adults with IgG Antibodies to Prior Symptomatic SARS-CoV-2 Infection

J Gen Intern Med 36(4):1156–8
DOI: 10.1007/s11606-020-06387-9

INTRODUCTION

While there is growing evidence that a majority of adults exposed to SARS-CoV-2 mount an IgG immune response,[1,2] little is known about the strength of this response. We conducted antibody testing of adults recovered from SARS-CoV-2 to evaluate potential differences in IgG titer levels based on age, sex, time from symptom onset, and duration of symptoms.

METHODS

We recruited symptomatic adults recovered from mild SARS-CoV-2 in the New York Tristate area for serum IgG measurement via a REDCap online survey (Vanderbilt University, Tennessee). Respondents were eligible for antibody testing if they had confirmed or high risk suspected symptomatic SARS-CoV-2 infection, defined as having symptoms consistent with SARS-CoV-2 and living someone who was confirmed positive, being told by their physician that they were positive, or working as a healthcare provider. Respondents self-reported date of symptom onset and last date of symptoms; duration of symptoms was calculated from these self-reported dates.

We collected serum IgG antibody titers using a serologic Mount Sinai ELISA test with FDA Emergency Use Authorization (Sn 96%, Sp 100%).[3] In the first 2 weeks of antibody testing, participants were required to be over 7 days from start of symptoms and greater than 3 days asymptomatic; after learning more time was required to mount immunity, we required participants to be over 21 days from symptom onset and greater than 14 days asymptomatic.

One-way ANOVA, Fisher's exact test, and ordinal logistic regression models were used to test whether age, sex, duration of symptoms, or time from symptom start to antibody titer result was associated with titer level. This study was determined to be exempt from Institutional Review Board review.

RESULTS

Between March 24, 2020, and May 15, 2020, we identified 3445 adults with positive antibody titers. Of these adults, 1778 indicated if they had prior positive PCR testing. Twenty-nine percent had titers of ≥ 1:2880, 34.6% had 1:960, 30.6% had 1:320, 4.3% had 1:160 and 1.1% had 1:80. Median time from symptom onset to antibody titer testing was 34 days (range 5–82); median symptom duration was 10 days (range 0–75). In a multivariate ordinal regression model including symptom duration, gender, and age by titer, older age predicted significantly higher odds of higher titer levels with an OR = 1.03 (95% confidence interval: 1.02–1.03). In univariate analyses, age greater than 40 years, male sex, and symptom duration were all associated with increasing IgG titer levels ($p < 0.01$) (Table 1). Ordinal logistic regression models suggested that age greater than 40 years (OR 1.69, CI 1.45–1.98) and male sex (OR 1.22, CI 1.05–1.42) were associated with increased titer levels.

As compared to people with symptoms less than 1 week, participants with symptoms lasting 1 to 2 weeks (OR 1.93, CI 1.63–2.28) or 2 or more weeks (OR 2.67, CI 2.12–3.36) had higher IgG titers. Time from symptom onset was not associated with differences in titer levels (Fig. 1).

DISCUSSION

We found that the majority of individuals with SARS-CoV-2 antibodies had a robust IgG antibody response. While we do not yet know what, if any, SARS-CoV-2 titer level may be associated with protective immunity,[4] understanding variability in immune response for different groups may have important implications for discussions of future immunity, potential risk for reinfection, and possible future vaccine response.

Though others have posited that older groups may be less likely to mount a strong humoral immune response, our data suggests otherwise, with older adults having a response at least as strong as their younger counterparts.

No prior presentations of this material.

Received July 8, 2020
Accepted December 2, 2020
Published online January 21, 2021

Table 1 Demographic Characteristics of Participants

	Positive Ab titers						
	Total (*N* = 3445)	**80 (*N* = 40)**	**160 (*N* = 148)**	**320 (*N* = 1053)**	**960 (*N* = 1193)**	**2880 (*N* = 1011)**	***p* value**
Sex, *N* (%)							0.115
Male	1779 (52)	17 (1)	72 (4)	518 (29)	623 (35)	549 (31)	
Female	1666 (48)	23 (1)	76 (5)	535 (32)	570 (34)	462 (28)	
Age, *N* (%)							< 0.0001
18–39	2049 (59)	21 (53)	99 (66)	700 (66)	774 (65)	455 (45)	
40+	1406 (41)	19 (48)	51 (34)	358 (34)	420 (35)	558 (55)	
Symptoms, *N* (%)							
Onset to result							< 0.0001
0–2 weeks	14 (1)	0 (0)	1 (1)	8 (1)	1 (0)	4 (1)	
2–3 weeks	223 (8)	2 (6)	11 (9)	100 (11)	69 (7)	41 (5)	
3–4 weeks	631 (22)	8 (25)	23 (18)	203 (23)	225 (22)	172 (20)	
> 4 weeks	2051 (70)	22 (69)	92 (72)	564 (65)	718 (71)	655 (75)	
Resolution to result							0.092
0–2 weeks	397 (17)	5 (19)	15 (14)	136 (19)	117 (14)	124 (17)	
2–3 weeks	562 (24)	5 (19)	25 (23)	152 (22)	212 (25)	168 (24)	
3–4 weeks	611 (26)	3 (12)	23 (22)	181 (26)	210 (25)	194 (27)	
> 4 weeks	811 (34)	13 (50)	44 (41)	231 (33)	297 (36)	226 (32)	
Symptom duration							< 0.0001
< 1 week	783 (33)	14 (58)	47 (45)	301 (43)	282 (34)	139 (20)	
1–2 weeks	1155 (49)	6 (25)	46 (44)	308 (44)	418 (50)	377 (54)	
> 2 weeks	419 (18)	4 (17)	12 (11)	84 (12)	131 (16)	188 (27)	

Male sex and duration of symptoms greater than 1 week were associated with higher titer levels. Other studies have shown that older individuals and men are disproportionately affected by SARS-CoV-2, so this may indicate higher viral burden with increased antigen availability in these groups.[5,6] Similarly, duration of symptoms may be a proxy for severity.

In our cohort, over 95% of recovered patients had mild to moderate COVID-19 that never required emergency department or hospitalization. Timing of symptoms was collected by self-report and may have been subject to recall bias. Additionally, we did not collect information regarding participant comorbidities which may confound results. Furthermore, since recruitment was through an online English survey, we may have over-representation here of younger, English-speaking individuals, not reflective of all groups affected by SARS-CoV-2.

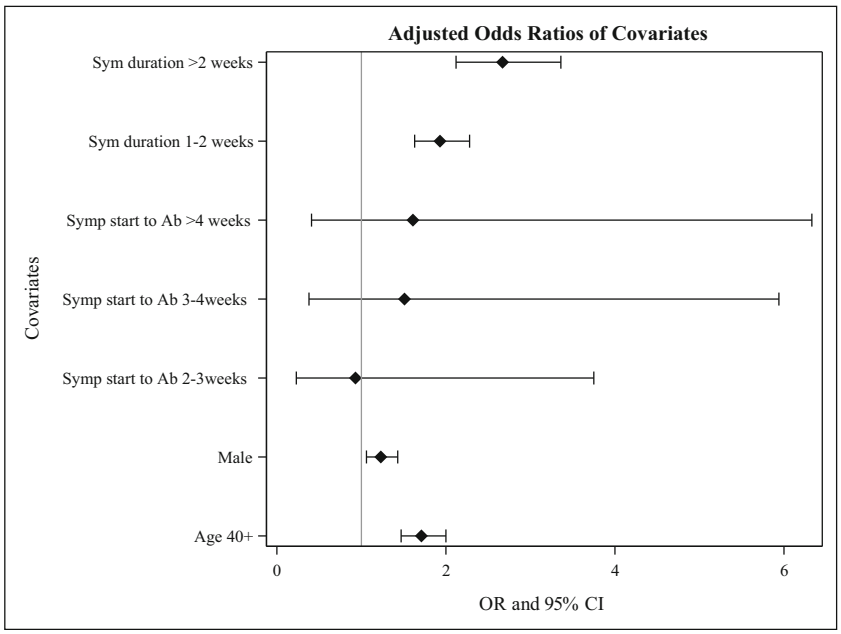

Figure 1 Adjusted odds ratios of demographic characteristics.

Acknowledgments: *Thank you to everyone on the Mount Sinai Convalescent Plasma Program Team for significant contributions to this work and manuscript including Deena Altman, MD; Nicole M. Bouvier, MD; Gopi Patel, MD; Kimberly Muellers, MPH; Kimberly Stone, MPH; Rao Mendu, PhD; Jeffrey Jhang, MD; Adolfo Firpo, MD; Judith Aberg, MD; Florian Krammer, PhD; David Reich, MD; and Carlos Cordon Cardo, MD, PhD.*
Thank you to all our convalescent plasma donors for participating in this program and to the medical students who assisted with outreaching and following up with our participants. Thank you to our clinical pathology lab colleagues and hospital leadership for providing support.

Mayce Mansour, MD[1]
Ania Wajnberg, MD[1]
Deena R. Altman, MD[2]
Kimberly Muellers, MPH[1]
Kimberly Stone, MPH[1]

[1]Department of General Internal Medicine, Icahn School of Medicine at Mount Sinai, 17 E 102nd St, 7th Floor, Box 1087, New York, NY 11216, USA
[2]Department of Medicine, Division of Infectious Disease, Icahn School of Medicine at Mount Sinai, New York, USA
[3]Icahn School of Medicine at Mount Sinai, New York, USA

Corresponding Author: *Mayce Mansour, MD; Department of General Internal Medicine, Icahn School of Medicine at Mount Sinai, 17 E 102nd St, 7th Floor, Box 1087, New York, NY 11216, USA (e-mail: mayce.mansour@mountsinai.org).*

Compliance with Ethical Standards:

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

REFERENCES

1. **Wajnberg A, Mansour M, Leven E, et al.** Humoral immune response and prolonged PCR positivity in a cohort of 1343 SARS-CoV 2 patients in the New York City region. medRxiv. 2020:2020.2004.2030.20085613.
2. **Zhao J, Yuan Q, Wang H, et al.** Antibody responses to SARS-CoV-2 in patients of novel coronavirus disease 2019. Clin Infect Dis 2020.
3. **Amanat F, Stadlbauer D, Strohmeier S, et al.** A serological assay to detect SARS-CoV-2 seroconversion in humans. Nat Med 2020.
4. **Krammer F**, **Simon V**. Serology assays to manage COVID-19. Science 2020.
5. **Zheng S, Fan J, Yu F, et al.** Viral load dynamics and disease severity in patients infected with SARS-CoV-2 in Zhejiang province, China, January-March 2020: retrospective cohort study. BMJ 2020;369:m1443.
6. **To KK, Zhang AJ, Hung IF, et al.** High titer and avidity of nonneutralizing antibodies against influenza vaccine antigen are associated with severe influenza. Clin Vaccine Immunol 2012;19(7):1012-1018.