

BMJ Paediatrics Open

BMJ Paediatrics Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Paediatrics Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjpaedsopen.bmj.com>).

If you have any questions on BMJ Paediatrics Open's open peer review process please email info.bmjpo@bmj.com

BMJ Paediatrics Open

SARS CoV-2 Seroprevalence in a US School District During COVID-19

Journal:	<i>BMJ Paediatrics Open</i>
Manuscript ID	bmjpo-2021-001259
Article Type:	Original research letter
Date Submitted by the Author:	11-Aug-2021
Complete List of Authors:	Bullis, Sean ; University of Vermont Medical Center Grebber, Benjamin; University of Vermont College of Medicine Cook, Sally; Vermont Department of Health Graham, Nancy; University of Vermont College of Medicine Carmolli, Marya; University of Vermont College of Medicine Dickson, Dorothy; University of Vermont College of Medicine Diehl, Sean; University of Vermont College of Medicine Kirkpatrick, Beth; University of Vermont College of Medicine Lee, Benjamin; University of Vermont College of Medicine; University of Vermont Medical Center
Keywords:	COVID-19

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

SARS CoV-2 Seroprevalence in a US School District During COVID-19

Sean S. M. Bullis^{a,b}, MD, Benjamin Grebber^b, Sally Cook^c, Nancy R. Graham^b, Marya Carmolli^b, Dorothy Dickson^b, Sean A. Diehl^b, PhD, Beth Kirkpatrick^{a,b}, MD, Benjamin Lee^{a,b}, MD.

Affiliations: ^aUniversity of Vermont Medical Center, Burlington, Vermont; ^bUniversity of Vermont, Larner College of Medicine, Burlington, Vermont; ^cVermont Department of Health.

Address correspondence to: Benjamin Lee, University of Vermont, Larner College of Medicine, 95 Carrigan Drive, Stafford 208, Burlington, VT, 05405, blee7@uvm.edu, 802-656-7748.

Word count: 597

1
2
3 **14 ABSTRACT**
4
5

6 **15** Reduced symptomatology and access to testing in children has led to underestimates of pediatric
7
8 **16** COVID-19 prevalence and raised concerns about school safety. To explore COVID-19
9
10 prevalence and risk factors in school settings, we conducted a SARS-CoV-2 serosurvey in a
11
12 Vermont, USA school district in December 2020. Among 336 students (63%) and 196
13
14 teachers/staff (37%), adjusted seroprevalence was 4.7% (95% CI, 2.9-7.2) and was lowest in
15
16 preK-5 students. Seroprevalence was 10-fold higher than corresponding state PCR data, but was
17
18 low overall with no evidence of onward transmissions. These results further support feasibility of
19
20 in-person learning during COVID-19 with appropriate mitigation measures.
21
22
23

24 **23 Keywords:** COVID-19, SARS-CoV-2, Serosurvey, Schools
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 25 At the beginning of the COVID-19 pandemic, near-universal school closures were enacted
4
5 26 to mitigate spread of SARS-CoV-2. Early studies suggested that children were less susceptible to
6
7 27 SARS-COV-2 and less likely to transmit [1]. However, their high frequency of asymptomatic
8
9 28 infections [2] called into question the accuracy of incidence estimates using symptoms-based
10
11 29 testing and the true role of pediatric transmission, concerns that heavily influenced school
12
13 30 reopening debates.
14
15
16
17

18 31 Therefore, we conducted a cross-sectional serosurvey to estimate COVID-19 prevalence
19
20 32 and risk factors among students and staff attending ≥ 2 days/week of in-person learning in
21
22 33 Colchester School District (Vermont, USA). Patients or the public were not involved in study
23
24 34 design, conduct, reporting, or dissemination. The University of Vermont Institutional Review
25
26 35 Board approved the study. All participants/parent provided written informed consent and all
27
28 36 children \geq grade 6 provided written assent. Capillary blood collection was performed December
29
30 37 2-19th, 2020 for detection of serum anti-SARS-CoV-2 IgG by ELISA [3], and participants
31
32 38 completed a self-administered REDCap questionnaire to assess risk factors (supplemental
33
34 39 materials). At the time of the study, state guidelines mandated universal masking and physical
35
36 40 distancing (three feet, pre-K-6; six feet, 7-12). Seroprevalence with 95% confidence intervals (CI)
37
38 41 were calculated using Blaker's method and adjusted for estimated assay sensitivity (95%) and
39
40 42 specificity (99%) [4].
41
42
43
44
45
46

47 43 532 enrolled participants completed antibody measurement: 336 students (63%) and 196
48
49 44 teachers/staff (37%). The participation rate was 18% among students, equally distributed across
50
51 45 age groups, and 44% among teachers/staff. Overall adjusted seroprevalence was 4.7% (95% CI,
52
53 46 2.9-7.2) and was similar among students and teachers/staff (**Table 1**). Adjusted seroprevalence
54
55 47 was lowest (1.8%, 95% CI 0.0-5.8) in pre-K-5 students. 527 participants (99%) completed the
56
57
58
59
60

1
2
3 48 questionnaire, including all seropositive individuals. 95% identified as white race alone, similar to
4
5 49 VT overall (94%). Two teachers/staff reported prior COVID-19; both were seronegative. 18
6
7
8 50 participants reported prior household COVID-19 contact between March and December 2020;
9
10 51 none were seropositive. 30 participants reported close non-household COVID-19 contact; only one
11
12 52 student was seropositive. No associations were detected between seropositivity and out-of-state
13
14 53 travel, sports participation, group activities, or symptomatic illness without confirmatory testing.
15
16
17 54 Nearly all (99%) reported that family members wore masks $\geq 75\%$ of the time in public.
18
19

20 55 In a low-incidence US region, we detected low SARS-CoV-2 seroprevalence among
21
22 56 students and staff attending in-person learning mid-way through the 2020-2021 academic year.
23
24 57 Seroprevalence increased with age, consistent with patterns of COVID-19 incidence in US
25
26 58 children [5]. As observed elsewhere, our findings suggest significant (10-fold) under-detection of
27
28 59 SARS-CoV-2 infections in US children [6]; cumulative incidence as calculated from state PCR in
29
30 60 December 2020 was 0.46% in children ≤ 19 . Our cohort reported few known contacts with SARS-
31
32 61 CoV-2-infected individuals, suggesting that missed asymptomatic infections may have occurred,
33
34 62 even in a low-risk population in a low-incidence region. Importantly however, our data indicate
35
36 63 that such infections were not associated with known cases of onward transmission. Of note, our
37
38 64 study occurred prior to vaccine roll-out and emergence of Delta variant.
39
40
41
42
43

44 65 Our study had several limitations. Participation was low, limiting precision and introducing
45
46 66 potential selection bias. These results may not be generalizable to other regions. We were unable
47
48 67 to perform antibody measurement before the school year, preventing estimation of the timing of
49
50 68 infections, and successful vaccine roll-out in 2021 precluded planned follow-up assessment.
51
52 69 Individuals with waning antibody responses may have been missed. Finally, questionnaire data are
53
54 70 subject to recall bias.
55
56
57
58
59
60

1
2
3 71 Our results further support the global experience demonstrating feasibility, with proper
4
5 72 mitigation, of in-person education during COVID-19. Until younger children are eligible for
6
7 73 vaccination and where community transmission remains high or vaccine coverage remains limited,
8
9
10 74 mitigation measures remain important to ensure safe in-person learning, particularly as more
11
12 75 infectious variants circulate.
13
14
15
16 76
17
18 77
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 78 **Acknowledgements:** The authors would like to thank Annie Penfield-Cyr for her assistance with
4
5 79 the REDCap database. The authors would like to thank Meghan Baule, Amy Minor, and Lindsey
6
7 80 Campion of the Colchester School District, the Vermont Department of Health, and multiple
8
9 81 volunteers from the Vermont Medical Reserve Corps and the University of Vermont Medical
10
11 82 Center and University of Vermont Larner College of Medicine for their assistance with the
12
13 83 study.
14
15
16
17

18 84 **Funding:** This work was supported by Children's Miracle Network Hospitals Fund [award
19
20 85 number not applicable] and NIH/NIGMS [P20 GM125498-01]. The funders had no role in the
21
22 86 design, conduct, analysis, or interpretation of this study.
23
24
25

26 87 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
27
28 88 www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the
29
30 89 submitted work; no financial relationships with any organisations that might have an interest in
31
32 90 the submitted work in the previous three years; no other relationships or activities that could
33
34 91 appear to have influenced the submitted work.
35
36
37
38

39 92 **Authors' contributions:** BL conceptualized and designed the study, managed recruitment,
40
41 93 enrollment, specimen collection, processing, and ELISA, performed data management and
42
43 94 analyses, and reviewed and revised the manuscript. SB performed specimen collection and
44
45 95 ELISA, data entry, drafted the initial manuscript, and reviewed and revised the manuscript. BG
46
47 96 and SC assisted with study instrument design, managed and performed specimen collection, and
48
49 97 reviewed and revised the manuscript. SD, NG, and MC established and/or performed ELISA,
50
51 98 and reviewed and revised the manuscript. DD assisted with study design, performed instrument
52
53 99 design and data management, performed analyses, and reviewed and revised the manuscript. BK
54
55
56
57
58
59
60

1
2
3 100 reviewed and revised the manuscript. All authors approved the final manuscript as submitted and
4
5 101 agree to be accountable for all aspects of the work.
6
7
8
9 102

Confidential: For Review Only

103 REFERENCES

- 104 1. Lee B, Raszka WV, Jr.: **COVID-19 Transmission and Children: The Child Is Not to**
105 **Blame.** *Pediatrics* 2020, **146**(2).
- 106 2. He J, Guo Y, Mao R, Zhang J: **Proportion of asymptomatic coronavirus disease 2019:**
107 **A systematic review and meta-analysis.** *J Med Virol* 2021, **93**(2):820-830.
- 108 3. Stadlbauer D, Amanat F, Chromikova V, Jiang K, Strohmeier S, Arunkumar GA, Tan J,
109 Bhavsar D, Capuano C, Kirkpatrick E *et al*: **SARS-CoV-2 Seroconversion in Humans:**
110 **A Detailed Protocol for a Serological Assay, Antigen Production, and Test Setup.**
111 *Curr Protoc Microbiol* 2020, **57**(1):e100.
- 112 4. **Mount Sinai Hospital Clinical Laboratory COVID-19 ELISA Antibody Test FDA**
113 **EUA** [<https://www.fda.gov/media/137030/download>]
- 114 5. Leeb RT, Price S, Sliwa S, Kimball A, Szucs L, Caruso E, Godfred-Cato S, Lozier M:
115 **COVID-19 Trends Among School-Aged Children - United States, March 1-**
116 **September 19, 2020.** *MMWR Morb Mortal Wkly Rep* 2020, **69**(39):1410-1415.
- 117 6. Hobbs CV, Drobeniuc J, Kittle T, Williams J, Byers P, Satheshkumar PS, Inagaki K,
118 Stephenson M, Kim SS, Patel MM *et al*: **Estimated SARS-CoV-2 Seroprevalence**
119 **Among Persons Aged <18 Years - Mississippi, May-September 2020.** *MMWR Morb*
120 *Mortal Wkly Rep* 2021, **70**(9):312-315.

121

Table 1 SARS-CoV-2 IgG seroprevalence

	Total N	Age, years median (IQR)	Seropositive N	Unadjusted seroprevalence % (95% CI)	Adjusted seroprevalence % (95% CI)
Teachers/staff	196	45.1 (36.3-53.4)	11	5.6 (2.9-9.8)	4.9 (2.0-9.3)
Students	336	12.2 (8.5-14.9)	18	5.4 (3.3-8.2)	4.6 (2.5-7.7)
PreK-5	149	8.3 (6.7-9.8)	4	2.7 (0.9-6.5)	1.8 (0.0-5.8)
Grades 6-8	82	13.1 (12.3-13.8)	6	7.3 (3.2-14.9)	6.7 (2.4-14.8)
Grades 9-12	105	16.1 (15.1-17.1)	8	7.6 (3.4-14.4)	7.0 (2.5-14.3)
Grades 6-12	187	14.6 (13.3-16.3)	14	7.5 (4.4-12.1)	6.9 (3.6-11.8)
Total	532	-	29	5.5 (3.7-7.7)	4.7 (2.9-7.2)

Abbreviations: CI, confidence interval; IQR, interquartile range; N, number.

122

COVID-19 Serosurvey Questionnaire #1

Thank you again for agreeing to participate in this study. This questionnaire will provide us with important information that we will use to understand your blood antibody results. It should take no longer than 5-10 minutes to complete. Please answer to the best of your ability. The results of this questionnaire will remain confidential.

You must complete this questionnaire in order for antibody test results to be released to you.

General instructions

As you navigate, please use the "Next Page" and "Previous Page" buttons at the bottom of the page, rather than the "Back" and "Forward" buttons on your browser. If you need to change a response, you can use the "Reset" buttons to clear your answer for that question. If at any time you need to stop and would like to resume later, please use the "Save & Return Later" button at the bottom of the page. You will be asked to write down a unique code to re-access your survey. If you forget to do this, that is ok, it just means you will need to start the survey over. If you have personal or health-related questions

At any time, if you have any questions involving personal or medical information, please call either [REDACTED] [REDACTED]. Please do NOT send us any emails that involve private information.

The questions on this survey refer to [general_info_arm_2][participant_firstname] [general_info_arm_2][participant_lastname]. If you have more than one child or household member participating, only answer these questions as they specifically pertain to [general_info_arm_2][participant_firstname] [general_info_arm_2][participant_lastname].

Questionnaire #1 Date

Which school(s) does [general_info_arm_2][participant_firstname] work in? Please select all that apply.

- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

Approximately how many hours of the day does [general_info_arm_2][participant_firstname] have direct contact with students, no matter the distance?

- 0 Hours
 - 1 Hour
 - 2 Hours
 - 3 Hours
 - 4 Hours
 - 5 Hours
 - 6 Hours
 - 7 Hours
 - 8 Hours
 - 9+ Hours
- ((Example: Teaching a classroom of students for 1 hour would equal 1 hour))

If you work at the district office or have a position where it is not routine to have direct contact with the students, please select "0 Hours."

1 Which grades does pre-K
2 [general_info_arm_2][participant_firstname] work K
3 with? Only include those grades where direct contact 1
4 is routine. Please select all that apply. 2
5 3
6 4
7 5
8 6
9 7
10 8
11 9
12 10
13 11
14 12

16 Has [general_info_arm_2][participant_firstname] ever Yes
17 had a positive test for COVID-19? No

19 If so, when? (Provide your best estimate if exact
20 date is unknown). _____
21

23 How many people live in 0
24 [general_info_arm_2][participant_firstname]'s home 1
25 (not including 2
26 [general_info_arm_2][participant_firstname]) right 3
27 now? 4
28 5
29 6
30 7
31 8
32 9
33 10

34 How many people in 0
35 [general_info_arm_2][participant_firstname]'s house 1
36 are under 21 years old? (Not including 2
37 [general_info_arm_2][participant_firstname]) 3
38 4
39 5
40 6
41 7
42 8
43 9
44 10

46 Does [general_info_arm_2][participant_firstname] live Yes
47 with anyone at home under the age of 21 that attends No
48 school outside of the Colchester School District?
49

50 If yes, which school(s) do they attend?
51 _____
52
53
54
55
56
57
58
59
60

1 Has either of Yes, mother
2 [general_info_arm_2][participant_firstname]'s Yes, father
3 parents ever had a positive test for COVID-19? If Yes, both parents
4 so, who? None
5 Not applicable

6 Only count parents who were living in the house with
7 [general_info_arm_2][participant_firstname] at they
8 time they were diagnosed.

9
10 If you are a teacher or staff member, this question
11 may not apply to you--if this is the case, please
12 select "Not applicable."

13
14 When was the parent diagnosed? (Provide your best
15 estimate if exact date is unknown). _____

16
17 If more than one parent was diagnosed, enter the MOST
18 RECENT date.

19
20 Has any of Yes, sister
21 [general_info_arm_2][participant_firstname]'s Yes, brother
22 siblings ever had a positive test for COVID-19? If Yes, more than one sibling
23 so, who? None
24 Not applicable

25 Only count siblings who were living in the house with
26 [general_info_arm_2][participant_firstname] at the
27 time they were diagnosed.

28
29 If you are a teacher or staff member, this question
30 may not apply to you--if this is the case, please
31 select "Not applicable."

32
33 How many total siblings were diagnosed with COVID-19? 2
34 3
35 4
36 5 or more

37
38 When was the sibling diagnosed? (Provide your best
39 estimate if exact date is unknown). _____

40
41 If more than one sibling was diagnosed, enter the
42 MOST RECENT date.

43
44 Has anybody else living with Yes
45 [general_info_arm_2][participant_firstname] ever had No
46 a positive test for COVID-19?

47
48 Who had a positive test for COVID-19 while living Yes, grandmother
49 with [general_info_arm_2][participant_firstname]? Yes, grandfather
50 You may check all that apply. Yes, child
51 Yes, other housemate

52 Only count people who were living in the house with
53 [general_info_arm_2][participant_firstname] at the
54 time they were diagnosed.

55
56 For this question, the answer choice "Child" only
57 applies to teachers and staff filling out their own
58 survey, to indicate if they have ever had a child
59 who had COVID-19 while living in the same house.
60

1 When was the grandparent diagnosed? (Provide your
2 best estimate if exact date is unknown). _____
3

4 If more than one grandparent was diagnosed, enter the
5 MOST RECENT date.
6

7 How many children living in the house were diagnosed
8 with COVID-19? 1
9 2
10 3
11 4
12 5 or more

13 When was your child diagnosed? (Provide your best
14 estimate if exact date is unknown). _____
15

16 If more than one child was diagnosed, enter the MOST
17 RECENT date.
18

19 How many other people living in the house were
20 diagnosed with COVID-19? 1
21 2
22 3
23 4
24 5 or more
25

26 List their relationships to
27 [general_info_arm_2][participant_firstname]
28 _____
29

30 When was the other housemate diagnosed? (Provide your
31 best estimate if exact date is unknown). _____
32

33 If more than one other housemate was diagnosed, enter
34 the MOST RECENT date.
35

36 Has [general_info_arm_2][participant_firstname] ever
37 been told to quarantine by the health department
38 because they were found to be a close contact of
39 someone OUTSIDE THE HOUSEHOLD with COVID-19? Yes
40 No

41 If so, when did the quarantine begin? (Provide your
42 best estimate if exact date is unknown) _____
43

44 If this has happened more than once, please enter the
45 MOST RECENT date.
46

47 Did [general_info_arm_2][participant_firstname]
48 participate in any organized summer activities (such
49 as camps or sports leagues), either as participant,
50 coach, or teacher/counselor, or attend organized day
51 care during the previous spring or summer? Yes
52 No

53 In which organized summer activities did
54 [general_info_arm_2][participant_firstname]
55 participate? Check all that apply.
56 Day camp (of any type)
57 Sleep-away camp
58 Sports league
59 Daycare
60 Other

1 If other, please explain:
2
3
4 _____
5

6 Since the beginning of school, has Yes
7 [general_info_arm_2][participant_firstname] been No
8 participating in any organized activities or been in
9 group settings, either as participant, coach, or
10 teacher/counselor?

11 Since the beginning of school, in which organized Sports team/league
12 activities or group settings has Other classes/lessons outside of school
13 [general_info_arm_2][participant_firstname] been Group child care or learning groups
14 participating? Please check all that apply. Other
15

16
17 If other, please explain:
18
19 _____
20

21 Since March 2020, has Yes
22 [general_info_arm_2][participant_firstname] traveled No
23 outside of Vermont?
24

25 Do NOT include travel for essential purposes, such as
26 for medical care or for visitation (for example, to
27 see a parent with joint custody but who lives
28 outside of Vermont).
29

30 If yes, where (city, state, country)?
31 _____

32 If there has been more than one trip outside of
33 Vermont, please enter information for the MOST
34 RECENT trip.
35

36 If yes, when did
37 [general_info_arm_2][participant_firstname] return
38 from travel? (Provide your best estimate if exact
39 date is unknown) _____
40

41 If there has been more than one trip outside of
42 Vermont, please enter the MOST RECENT date.
43

44 Since March 2020, did Yes
45 [general_info_arm_2][participant_firstname] ever had No
46 any symptoms concerning for COVID-19 but for which
47 [general_info_arm_2][participant_firstname] could
48 not get tested?
49

50 If this has happened more than once, please answer
51 the following questions for the MOST RECENT illness
52 for which testing could not be performed.
53
54
55
56
57
58
59
60

1 If so, which symptoms? (Please check all that apply)

- 2 Fever or chills
 3 Cough
 4 Shortness of breath or difficulty breathing
 5 Fatigue
 6 Muscle or body aches
 7 Headache
 8 New loss of taste or smell
 9 Sore throat
 10 Congestion or runny nose
 11 Nausea or vomiting
 12 Diarrhea

13 If so, please indicate the approximate date when
 14 these symptoms began. _____

16 Is anyone in
 17 [general_info_arm_2][participant_firstname]'s
 18 household considered an essential worker?

- 16 Yes
 17 No
 18 Not sure

21 If so, please list who (parent, grandparent, sibling,
 22 etc.) is an essential worker and their occupation.

23 If more than one, please list all essential workers. _____

26 On average, how frequently does everyone in the
 27 household wear masks or cloth facial coverings when
 28 in public?

- 26 None of the time
 27 < 25% of the time
 28 25-49% of the time
 29 50-74% of the time
 30 75% of the time or more

32 Is [general_info_arm_2][participant_firstname]
 33 Hispanic/Latino or not Hispanic/Latino?

- 32 Hispanic/Latino
 33 Not Hispanic/Latino
 34 Prefer not to answer

36 What is [general_info_arm_2][participant_firstname]'s
 37 race? Select one or more.

- 36 American Indian or Alaskan Native
 37 Asian
 38 Black or African American
 39 Native Hawaiian or Other Pacific Islander
 40 White
 41 Prefer not to answer

43 To complete the survey, please click "Submit" below. Once you click "Submit," you cannot change any of your
 44 answers. You may go back now to review any of your answers if desired by clicking the "Previous Page" buttons.

46 After you submit, you will receive a separate email link that will allow you to access the antibody test results for
 47 [general_info_arm_2][participant_firstname].

BMJ Paediatrics Open

SARS CoV-2 Seroprevalence in a US School District During COVID-19

Journal:	<i>BMJ Paediatrics Open</i>
Manuscript ID	bmjpo-2021-001259.R1
Article Type:	Original research letter
Date Submitted by the Author:	16-Sep-2021
Complete List of Authors:	Bullis, Sean ; University of Vermont Medical Center Grebber, Benjamin; University of Vermont College of Medicine Cook, Sally; Vermont Department of Health Graham, Nancy; University of Vermont College of Medicine Carmolli, Marya; University of Vermont College of Medicine Dickson, Dorothy; University of Vermont College of Medicine Diehl, Sean; University of Vermont College of Medicine Kirkpatrick, Beth; University of Vermont College of Medicine Lee, Benjamin; University of Vermont College of Medicine; University of Vermont Medical Center
Keywords:	COVID-19

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

SARS CoV-2 Seroprevalence in a US School District During COVID-19

Sean S. M. Bullis^{a,b}, MD, Benjamin Grebber^b, Sally Cook^c, Nancy R. Graham^b, Marya Carmolli^b, Dorothy Dickson^b, Sean A. Diehl^b, PhD, Beth Kirkpatrick^{a,b}, MD, Benjamin Lee^{a,b}, MD.

Affiliations: ^aUniversity of Vermont Medical Center, Burlington, Vermont; ^bUniversity of Vermont, Larner College of Medicine, Burlington, Vermont; ^cVermont Department of Health.

Address correspondence to: Benjamin Lee, University of Vermont, Larner College of Medicine, 95 Carrigan Drive, Stafford 208, Burlington, VT, 05405, blee7@uvm.edu, 802-656-7748.

Word count: 677

1
2
3 14 **ABSTRACT**
4
5

6 15 Reduced symptomatology and access to testing in children has led to underestimates of pediatric
7
8
9 16 COVID-19 prevalence and raised concerns about school safety. To explore COVID-19
10
11 17 prevalence and risk factors in school settings, we conducted a SARS-CoV-2 serosurvey in a
12
13 18 Vermont, USA school district in December 2020. Among 336 students (63%) and 196
14
15 19 teachers/staff (37%), adjusted seroprevalence was 4.7% (95% CI, 2.9-7.2) and was lowest in
16
17 20 preK-5 students. Seroprevalence was 10-fold higher than corresponding state PCR data, but was
18
19 21 low overall with no evidence of onward transmissions. These results further support feasibility of
20
21 22 in-person learning during COVID-19 with appropriate mitigation measures.
22
23
24

25
26 23 **Keywords:** COVID-19, SARS-CoV-2, Serosurvey, Schools
27
28
29 24
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 25 At the beginning of the COVID-19 pandemic, near-universal school closures were enacted
4
5 26 to mitigate spread of SARS-CoV-2. Early studies suggested that children were less susceptible to
6
7 27 SARS-COV-2 and less likely to transmit.[1] However, their high frequency of asymptomatic
8
9 28 infections [2] called into question the accuracy of incidence estimates using symptoms-based
10
11 29 testing and the true role of pediatric transmission, concerns that heavily influenced school
12
13 30 reopening debates.
14
15
16
17

18 31 Therefore, we conducted a cross-sectional serosurvey to estimate COVID-19 prevalence
19
20 32 and risk factors among students and staff attending ≥ 2 days/week of in-person learning in
21
22 33 Colchester School District (Vermont, USA). Patients or the public were not involved in study
23
24 34 design, conduct, reporting, or dissemination. The University of Vermont Institutional Review
25
26 35 Board approved the study. All participants/parent provided written informed consent and all
27
28 36 children \geq grade 6 provided written assent. Exclusion criteria including bleeding or clotting
29
30 37 disorder or other condition that would preclude safe blood collection. Capillary blood collection
31
32 38 via fingerprick was performed December 2-19th, 2020 for detection of serum anti-SARS-CoV-2
33
34 39 IgG using the Mount Sinai two-step ELISA, which requires detection of antibodies to both receptor
35
36 40 binding domain and full-length spike protein.[3-4] Participants completed a self-administered
37
38 41 REDCap questionnaire to assess risk factors (supplemental materials). At the time of the study,
39
40 42 state guidelines mandated universal masking for all students and staff and physical distancing of
41
42 43 three feet for pre-Kindergarten (pre-K)-6th grade students and six feet for 7th-12th grade students.
43
44 44 Seroprevalence with 95% confidence intervals (CI) were calculated using Blaker's method and
45
46 45 adjusted for estimated assay sensitivity (95%) and specificity (99%) according to the formula
47
48 46 $prevalence_{adjusted} = (prevalence_{observed} + specificity - 1)/(sensitivity + specificity - 1)$. [4-5]
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 47 532 enrolled participants completed antibody measurement: 336 students (63%) and 196
4
5 48 teachers/staff (37%). The participation rate was 18% among students, equally distributed across
6
7 49 age groups, and 44% among teachers/staff. Overall adjusted seroprevalence was 4.7% (95% CI,
8
9 50 2.9-7.2) and was similar among students and teachers/staff (**Table 1**). Adjusted seroprevalence
10
11 51 was lowest (1.8%, 95% CI 0.0-5.8) in pre-K-5 students. 527 participants (99%) completed the
12
13 52 questionnaire, including all seropositive individuals. 95% identified as white race alone, similar to
14
15 53 Vermont overall (94%). Two teachers/staff reported prior COVID-19; both were seronegative. 18
16
17 54 participants reported prior household COVID-19 contact between March and December 2020;
18
19 55 none were seropositive. 30 participants reported close non-household COVID-19 contact; only one
20
21 56 student was seropositive. No associations were detected between seropositivity and out-of-state
22
23 57 travel, sports participation, group activities, or symptomatic illness without confirmatory testing.
24
25 58 Nearly all (99%) reported that family members wore masks $\geq 75\%$ of the time in public.

26
27
28
29
30
31 59 In a low-incidence US region, we detected low SARS-CoV-2 seroprevalence among
32
33 60 students and staff attending in-person learning mid-way through the 2020-2021 academic year.
34
35 61 Seroprevalence increased with age, consistent with patterns of COVID-19 incidence in US
36
37 62 children.[6] As observed elsewhere, our findings suggest significant (10-fold) under-detection of
38
39 63 SARS-CoV-2 infections in US children.[7] Cumulative incidence in Vermont as calculated from
40
41 64 census and Vermont Department of Health PCR as of December 2020 was 0.46% in children
42
43 65 ≤ 19 . [8-9] Our cohort reported few known contacts with SARS-CoV-2-infected individuals,
44
45 66 suggesting that missed asymptomatic infections may have occurred, even in a low-risk population
46
47 67 in a low-incidence region. Importantly however, our data indicate that such infections were not
48
49 68 associated with known cases of onward transmission. Of note, our study occurred prior to vaccine
50
51 69 roll-out and significant emergence of the more infections Alpha and Delta variants.

1
2
3 70 Our study had several limitations. Participation was limited to a single school district and
4
5 71 response rate was low, limiting precision and introducing potential selection bias, meaning results
6
7 72 may not be readily generalizable. We were unable to perform antibody measurement before the
8
9 73 school year, preventing estimation of the timing of infections, and successful vaccine roll-out in
10
11 74 2021 precluded planned follow-up assessment. Individuals with waning antibody responses may
12
13 75 have been missed. Finally, questionnaire data are subject to recall bias.
14
15
16
17

18 76 Our results further support the global experience demonstrating feasibility, with proper
19
20 77 mitigation, of in-person education during COVID-19. Until younger children are eligible for
21
22 78 vaccination and where community transmission remains high or vaccine coverage remains limited,
23
24 79 mitigation measures remain important to ensure safe in-person learning, particularly as more
25
26 80 infectious variants circulate.
27
28
29

30 81

31
32
33 82
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

83 **Acknowledgements:** The authors would like to thank Annie Penfield-Cyr for her assistance with
84 the REDCap database. The authors would like to thank Meghan Baule, Amy Minor, and Lindsey
85 Campion of the Colchester School District, the Vermont Department of Health, and multiple
86 volunteers from the Vermont Medical Reserve Corps and the University of Vermont Medical
87 Center and University of Vermont Larner College of Medicine for their assistance with the
88 study.

89 **Funding:** This work was supported by Children's Miracle Network Hospitals Fund [award
90 number not applicable] and NIH/NIGMS [P20 GM125498-01]. The funders had no role in the
91 design, conduct, analysis, or interpretation of this study.

92 **Competing interests:** All authors have completed the ICMJE uniform disclosure form at
93 www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the
94 submitted work; no financial relationships with any organisations that might have an interest in
95 the submitted work in the previous three years; no other relationships or activities that could
96 appear to have influenced the submitted work.

97 **Authors' contributions:** BL conceptualized and designed the study, managed recruitment,
98 enrollment, specimen collection, processing, and ELISA, performed data management and
99 analyses, and reviewed and revised the manuscript. SB performed specimen collection and
100 ELISA, data entry, drafted the initial manuscript, and reviewed and revised the manuscript. BG
101 and SC assisted with study instrument design, managed and performed specimen collection, and
102 reviewed and revised the manuscript. SD, NG, and MC established and/or performed ELISA,
103 and reviewed and revised the manuscript. DD assisted with study design, performed instrument
104 design and data management, performed analyses, and reviewed and revised the manuscript. BK

1
2
3 105 reviewed and revised the manuscript. All authors approved the final manuscript as submitted and
4
5 106 agree to be accountable for all aspects of the work.
6
7
8
9 107

Confidential: For Review Only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

108 **REFERENCES**

- 109 1. Lee B, Raszka WV, Jr. COVID-19 Transmission and Children: The Child Is Not to Blame.
110 *Pediatrics* 2020;146(2) doi: 10.1542/peds.2020-004879 [published Online First:
111 2020/05/28]
- 112 2. He J, Guo Y, Mao R, et al. Proportion of asymptomatic coronavirus disease 2019: A
113 systematic review and meta-analysis. *J Med Virol* 2021;93(2):820-30. doi:
114 10.1002/jmv.26326 [published Online First: 2020/07/22]
- 115 3. Stadlbauer D, Amanat F, Chromikova V, et al. SARS-CoV-2 Seroconversion in Humans: A
116 Detailed Protocol for a Serological Assay, Antigen Production, and Test Setup. *Curr*
117 *Protoc Microbiol* 2020;57(1):e100. doi: 10.1002/cpmc.100 [published Online First:
118 2020/04/18]
- 119 4. Mount Sinai Hospital Laboratory COVID-19 ELISA IgG Antibody Test EUA Summary
120 [Available from: <https://www.fda.gov/media/137029/download> accessed March 11, 2021.
- 121 5. Reiczigel J, Földi J, Ozsvári L. Exact confidence limits for prevalence of a disease with an
122 imperfect diagnostic test. *Epidemiol Infect* 2010;138(11):1674-8. doi:
123 10.1017/s0950268810000385 [published Online First: 2010/03/04]
- 124 6. Leeb RT, Price S, Sliwa S, et al. COVID-19 Trends Among School-Aged Children - United
125 States, March 1-September 19, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(39):1410-
126 15. doi: 10.15585/mmwr.mm6939e2 [published Online First: 2020/10/02]
- 127 7. Hobbs CV, Drobeniuc J, Kittle T, et al. Estimated SARS-CoV-2 Seroprevalence Among
128 Persons Aged <18 Years - Mississippi, May-September 2020. *MMWR Morb Mortal Wkly*
129 *Rep* 2021;70(9):312-15. doi: 10.15585/mmwr.mm7009a4 [published Online First:
130 2021/03/05]

- 1
2
3 131 8. Current Activity in Vermont: Vermont Department of Health; [Available from:
4
5 132 <https://www.healthvermont.gov/response/coronavirus-covid-19/current-activity-vermont>
6
7
8 133 accessed March 15, 2021.
9
10 134 9. QuickFacts: Chittenden County, Vermont: United States Census Bureau; [Available from:
11
12 135 <https://www.census.gov/quickfacts/fact/table/chittendencountyvermont,VT/PST045219>
13
14 136 accessed March 3, 2021.
15
16
17 137
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1 SARS-CoV-2 IgG seroprevalence

	Total N	Age, years median (IQR)	Seropositive N	Unadjusted seroprevalence % (95% CI)	Adjusted seroprevalence % (95% CI)
Teachers/staff	196	45.1 (36.3-53.4)	11	5.6 (2.9-9.8)	4.9 (2.0-9.3)
Students	336	12.2 (8.5-14.9)	18	5.4 (3.3-8.2)	4.6 (2.5-7.7)
PreK-5	149	8.3 (6.7-9.8)	4	2.7 (0.9-6.5)	1.8 (0.0-5.8)
Grades 6-8	82	13.1 (12.3-13.8)	6	7.3 (3.2-14.9)	6.7 (2.4-14.8)
Grades 9-12	105	16.1 (15.1-17.1)	8	7.6 (3.4-14.4)	7.0 (2.5-14.3)
Grades 6-12	187	14.6 (13.3-16.3)	14	7.5 (4.4-12.1)	6.9 (3.6-11.8)
Total	532	-	29	5.5 (3.7-7.7)	4.7 (2.9-7.2)

Abbreviations: CI, confidence interval; IQR, interquartile range; N, number.

138

COVID-19 Serosurvey Questionnaire #1

Thank you again for agreeing to participate in this study. This questionnaire will provide us with important information that we will use to understand your blood antibody results. It should take no longer than 5-10 minutes to complete. Please answer to the best of your ability. The results of this questionnaire will remain confidential.

You must complete this questionnaire in order for antibody test results to be released to you.

General instructions

As you navigate, please use the "Next Page" and "Previous Page" buttons at the bottom of the page, rather than the "Back" and "Forward" buttons on your browser. If you need to change a response, you can use the "Reset" buttons to clear your answer for that question. If at any time you need to stop and would like to resume later, please use the "Save & Return Later" button at the bottom of the page. You will be asked to write down a unique code to re-access your survey. If you forget to do this, that is ok, it just means you will need to start the survey over. If you have personal or health-related questions

At any time, if you have any questions involving personal or medical information, please call either [REDACTED] [REDACTED]. Please do NOT send us any emails that involve private information.

The questions on this survey refer to [general_info_arm_2][participant_firstname] [general_info_arm_2][participant_lastname]. If you have more than one child or household member participating, only answer these questions as they specifically pertain to [general_info_arm_2][participant_firstname] [general_info_arm_2][participant_lastname].

Questionnaire #1 Date

Which school(s) does [general_info_arm_2][participant_firstname] work in? Please select all that apply.

Approximately how many hours of the day does [general_info_arm_2][participant_firstname] have direct contact with students, no matter the distance?

- 0 Hours
 1 Hour
 2 Hours
 3 Hours
 4 Hours
 5 Hours
 6 Hours
 7 Hours
 8 Hours
 9+ Hours

If you work at the district office or have a position where it is not routine to have direct contact with the students, please select "0 Hours."

((Example: Teaching a classroom of students for 1 hour would equal 1 hour))

1 Which grades does pre-K
2 [general_info_arm_2][participant_firstname] work K
3 with? Only include those grades where direct contact 1
4 is routine. Please select all that apply. 2
5 3
6 4
7 5
8 6
9 7
10 8
11 9
12 10
13 11
14 12

16 Has [general_info_arm_2][participant_firstname] ever Yes
17 had a positive test for COVID-19? No

19 If so, when? (Provide your best estimate if exact
20 date is unknown). _____
21

23 How many people live in 0
24 [general_info_arm_2][participant_firstname]'s home 1
25 (not including 2
26 [general_info_arm_2][participant_firstname]) right 3
27 now? 4
28 5
29 6
30 7
31 8
32 9
33 10

34 How many people in 0
35 [general_info_arm_2][participant_firstname]'s house 1
36 are under 21 years old? (Not including 2
37 [general_info_arm_2][participant_firstname]) 3
38 4
39 5
40 6
41 7
42 8
43 9
44 10

46 Does [general_info_arm_2][participant_firstname] live Yes
47 with anyone at home under the age of 21 that attends No
48 school outside of the Colchester School District?
49

50 If yes, which school(s) do they attend?
51 _____
52
53
54
55
56
57
58
59
60

1 Has either of Yes, mother
2 [general_info_arm_2][participant_firstname]'s Yes, father
3 parents ever had a positive test for COVID-19? If Yes, both parents
4 so, who? None
5 Not applicable

6 Only count parents who were living in the house with
7 [general_info_arm_2][participant_firstname] at they
8 time they were diagnosed.

9
10 If you are a teacher or staff member, this question
11 may not apply to you--if this is the case, please
12 select "Not applicable."

13
14 When was the parent diagnosed? (Provide your best
15 estimate if exact date is unknown). _____

16
17 If more than one parent was diagnosed, enter the MOST
18 RECENT date.

19
20 Has any of Yes, sister
21 [general_info_arm_2][participant_firstname]'s Yes, brother
22 siblings ever had a positive test for COVID-19? If Yes, more than one sibling
23 so, who? None
24 Not applicable

25 Only count siblings who were living in the house with
26 [general_info_arm_2][participant_firstname] at the
27 time they were diagnosed.

28
29 If you are a teacher or staff member, this question
30 may not apply to you--if this is the case, please
31 select "Not applicable."

32
33 How many total siblings were diagnosed with COVID-19? 2
34 3
35 4
36 5 or more

37
38 When was the sibling diagnosed? (Provide your best
39 estimate if exact date is unknown). _____

40
41 If more than one sibling was diagnosed, enter the
42 MOST RECENT date.

43
44 Has anybody else living with Yes
45 [general_info_arm_2][participant_firstname] ever had No
46 a positive test for COVID-19?

47
48 Who had a positive test for COVID-19 while living Yes, grandmother
49 with [general_info_arm_2][participant_firstname]? Yes, grandfather
50 You may check all that apply. Yes, child
51 Yes, other housemate

52 Only count people who were living in the house with
53 [general_info_arm_2][participant_firstname] at the
54 time they were diagnosed.

55
56 For this question, the answer choice "Child" only
57 applies to teachers and staff filling out their own
58 survey, to indicate if they have ever had a child
59 who had COVID-19 while living in the same house.
60

1 When was the grandparent diagnosed? (Provide your
2 best estimate if exact date is unknown). _____
3

4 If more than one grandparent was diagnosed, enter the
5 MOST RECENT date. _____
6

7 How many children living in the house were diagnosed
8 with COVID-19? 1
9 2
10 3
11 4
12 5 or more

13 When was your child diagnosed? (Provide your best
14 estimate if exact date is unknown). _____
15

16 If more than one child was diagnosed, enter the MOST
17 RECENT date. _____
18

19 How many other people living in the house were
20 diagnosed with COVID-19? 1
21 2
22 3
23 4
24 5 or more

25 List their relationships to
26 [general_info_arm_2][participant_firstname]
27 _____
28
29

30 When was the other housemate diagnosed? (Provide your
31 best estimate if exact date is unknown). _____
32

33 If more than one other housemate was diagnosed, enter
34 the MOST RECENT date. _____
35

36 Has [general_info_arm_2][participant_firstname] ever
37 been told to quarantine by the health department
38 because they were found to be a close contact of
39 someone OUTSIDE THE HOUSEHOLD with COVID-19? Yes
40 No

41 If so, when did the quarantine begin? (Provide your
42 best estimate if exact date is unknown) _____
43

44 If this has happened more than once, please enter the
45 MOST RECENT date. _____
46

47 Did [general_info_arm_2][participant_firstname]
48 participate in any organized summer activities (such
49 as camps or sports leagues), either as participant,
50 coach, or teacher/counselor, or attend organized day
51 care during the previous spring or summer? Yes
52 No

53 In which organized summer activities did
54 [general_info_arm_2][participant_firstname]
55 participate? Check all that apply. Day camp (of any type)
56 Sleep-away camp
57 Sports league
58 Daycare
59 Other
60

1 If other, please explain:
2
3
4 _____

5 Since the beginning of school, has
6 [general_info_arm_2][participant_firstname] been
7 participating in any organized activities or been in
8 group settings, either as participant, coach, or
9 teacher/counselor?
10

- Yes
 No

11 Since the beginning of school, in which organized
12 activities or group settings has
13 [general_info_arm_2][participant_firstname] been
14 participating? Please check all that apply.
15

- Sports team/league
 Other classes/lessons outside of school
 Group child care or learning groups
 Other

16
17 If other, please explain:
18
19 _____

20
21 Since March 2020, has
22 [general_info_arm_2][participant_firstname] traveled
23 outside of Vermont?
24

- Yes
 No

25 Do NOT include travel for essential purposes, such as
26 for medical care or for visitation (for example, to
27 see a parent with joint custody but who lives
28 outside of Vermont).
29

30 If yes, where (city, state, country)?
31 _____

32 If there has been more than one trip outside of
33 Vermont, please enter information for the MOST
34 RECENT trip.
35

36 If yes, when did
37 [general_info_arm_2][participant_firstname] return
38 from travel? (Provide your best estimate if exact
39 date is unknown)
40 _____

41 If there has been more than one trip outside of
42 Vermont, please enter the MOST RECENT date.
43

44 Since March 2020, did
45 [general_info_arm_2][participant_firstname] ever had
46 any symptoms concerning for COVID-19 but for which
47 [general_info_arm_2][participant_firstname] could
48 not get tested?
49

- Yes
 No

50 If this has happened more than once, please answer
51 the following questions for the MOST RECENT illness
52 for which testing could not be performed.
53
54
55
56
57
58
59
60

1 If so, which symptoms? (Please check all that apply)

2 Fever or chills

3 Cough

4 Shortness of breath or difficulty breathing

5 Fatigue

6 Muscle or body aches

7 Headache

8 New loss of taste or smell

9 Sore throat

10 Congestion or runny nose

11 Nausea or vomiting

12 Diarrhea

13 If so, please indicate the approximate date when

14 these symptoms began. _____

16 Is anyone in

17 [general_info_arm_2][participant_firstname]'s

18 household considered an essential worker?

19 Yes

20 No

21 Not sure

21 If so, please list who (parent, grandparent, sibling,

22 etc.) is an essential worker and their occupation.

23 _____

24 If more than one, please list all essential workers.

26 On average, how frequently does everyone in the

27 household wear masks or cloth facial coverings when

28 in public?

29 None of the time

30 < 25% of the time

31 25-49% of the time

32 50-74% of the time

33 75% of the time or more

32 Is [general_info_arm_2][participant_firstname]

33 Hispanic/Latino or not Hispanic/Latino?

34 Hispanic/Latino

35 Not Hispanic/Latino

36 Prefer not to answer

36 What is [general_info_arm_2][participant_firstname]'s

37 race? Select one or more.

38 American Indian or Alaskan Native

39 Asian

40 Black or African American

41 Native Hawaiian or Other Pacific Islander

42 White

43 Prefer not to answer

43 To complete the survey, please click "Submit" below. Once you click "Submit," you cannot change any of your

44 answers. You may go back now to review any of your answers if desired by clicking the "Previous Page" buttons.

45

46 After you submit, you will receive a separate email link that will allow you to access the antibody test results for

47 [general_info_arm_2][participant_firstname].

48

49

50

51

52

53

54

55

56

57

58

59

60