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Original Research

An evaluation of a pilot of daily testing of SARS-CoV-2 contacts in acute hospital and ambulance trusts in England

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ABSTRACT

Objectives: Healthcare worker (HCW) SARS-CoV-2 contacts in England have been required to quarantine, creating staff shortages. We piloted daily contact testing (DCT) to assess its feasibility as an alternative.
Study design: Observational service evaluation.
Methods: We conducted an observational service evaluation of 7-day DCT using antigen lateral flow devices (LFDs) at four acute hospital trusts and one ambulance trust in England. Mixed methods were used, using aggregate and individual-level test monitoring data, semi-structured interviews, and a survey of eligible contacts.
Results: In total, 138 HCWs were identified as contacts of a confirmed SARS-CoV-2 case. Of these, 111 (80%) consented to daily LFD testing, of whom 82 (74%) completed the required programme without interruption and 12 (11%) completed with interruption. Fifty-eight participants (52%) and two non-participants (7.4%) completed the survey. In total, 28 interviews were conducted with participants, site and infection control leads, and union representatives. One participant tested positive on LFD and polymerase chain reaction (PCR) test. Three participants tested positive on PCR but not LFD. DCT was well-accepted by trusts and staff. Participants reported no relaxation of their infection prevention and control behaviours. No incidents of transmission were detected. An estimated 729 potential days of work absence were averted.
Conclusions: DCT can be acceptably operated in a healthcare setting, averting quarantine-related work absences in HCW SARS-CoV-2 contacts.

Introduction

During the winter of 2020–21, large numbers of UK healthcare worker (HCW) staff were identified as contacts of a confirmed SARS-CoV-2 case and were required to quarantine. As a result, many hospitals struggled to staff critical services.[1]

Modelling suggests that daily contact testing (DCT) using antigen-detecting lateral flow devices (LFDs) could mitigate transmission as effectively as quarantining contacts.[2,3] LFDs are most sensitive for cases with high viral loads (a marker of infectiousness).[4] Daily LFD testing could detect asymptomatic but infectious individuals before they expose anyone else, whilst allowing non-infectious individuals to continue working. This could increase detection rates of asymptomatic infection (increasing the opportunities for contact tracing and surveillance of virus variants), whilst minimising the number of unnecessary quarantine days. School-based models suggest that DCT would result in fewer school days missed, at a cost of slightly higher levels of infection.[5,6]

A study of 1760 contacts from the UK general public reported DCT uptake of 50.1%, with 69.6% of participants reporting at least

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one result, 17.9% testing positive, and a secondary attack rate similar to a quarantine comparator group.[7,8] A cluster-randomised trial of 201 schools reported DCT uptake of 42.4%. It found DCT was non-inferior to quarantine for SARS-CoV-2 transmission, though did not demonstrate superiority in averting school absences.[9] DCT has also been conducted with essential workers and private businesses, although results have not been published.[10–12] This article evaluates a pilot of DCT conducted in HCWs to assess the acceptability and feasibility of implementation in the UK National Health Service (NHS), factors influencing participation and adherence, and the effect on behaviour, workplace infections, and workforce levels.

Method

Study design

NHS Test and Trace (T&T) and NHS England and NHS Improvement (NHSEI) recruited volunteers from NHS trusts experiencing high levels of workforce absence and operational pressure. Trusts commenced the pilot between 9th and 22nd January 2021. Recruitment of participants to the formal evaluation ended on 28th February 2021. Mixed methods were used, including an online survey of participants, semi-structured interviews with participants, site leads, union representatives and infection prevention and control (IPC) leads, and aggregate and individual-level test result monitoring data for all participants.

Intervention

A standard operating procedure for DCT was prepared by T&T and adapted for healthcare settings by NHSEI with one of the participating trusts. Subject to risk assessment, participating NHS trusts were permitted to tailor certain aspects, although the following components were common to all (see Supplementary materials 1 and 2).

HCWs were eligible if they were a non-household SARS-CoV-2 contact identified through workplace or national contact tracing, or the NHS COVID-19 app. On 26th January 2021, eligibility was extended to household contacts with evidence of recent SARS-CoV-2 infection (demonstrated by a positive polymerase chain reaction [PCR] test within the previous 90 days).

Contacts were required to self-test with an INNOVA SARS-CoV-2 LFD before attending work for seven consecutive days starting from the initial notification of exposure, or up till the end of their would-be 10-day quarantine period, if that was sooner.

Participants who developed major COVID-19 symptoms or tested positive on LFD were required to immediately quarantine and take a PCR test. If this was negative, they could continue with DCT.

Data collection

Participating trusts reported anonymised data about eligible HCWs, including age, ethnicity, gender, job role, vaccination status, date of exposure, and LFD and PCR test results. Trusts provided estimates of staff time required for setup and administration of the pilot.

Participating trusts were asked to email an online survey to all eligible HCWs, asking for sociodemographic, occupational and vaccination data (Table 2), views on the DCT policy, reasons for participating or declining, and experience of the daily LFD testing process (Supplementary materials 3 and 4).

Semi-structured telephone interviews were conducted with all trust DCT leads, and with up to one union representative and two DCT participants per trust, all of whom were recruited by trust DCT leads. DCT leads were asked about their experiences and the views of the workforce. Union representatives were asked about their perceptions. Participants were asked about their experience of DCT. IPC leads at each trust were asked whether there were any outbreaks or cases linked to DCT.

Relevant feedback from the working group of DCT pilot leads from T&T, NHSEI, and NHS trusts, which met weekly to oversee the operationalisation and evaluation of the pilot, was recorded.

Data analysis

Interview transcripts and survey responses were coded thematically, iteratively until saturation, by a single researcher.

National pay scales were applied to the staff resource estimates, to give a total financial value of initial setup and weekly running costs.[13–17] The number of potential days of work absence averted was counted as the number of LFD negative results during the quarantine period, plus any days remaining from the quarantine period for those who returned a negative result on their last day of testing, if on day 7, 8, or 9, up to a maximum of 10 per participant. The totals for each trust were divided by the number of weeks that the trust was in the pilot, giving the mean weekly number of potential days of work absence averted. Weekly running costs were divided by weekly potential days of work absence averted to calculate the mean cost per potential day of work absence averted.

Confidence intervals were calculated using the Wilson score method.

Results

Participants

Four large multisite acute hospital trusts in London (2), Oxford and Lancashire and a London ambulance trust participated.

In total, 138 HCW contacts were identified as eligible, of whom 80% (95% CI: 73%–86%, $n = 111$) chose to participate in DCT. Of these, 74% (95% CI: 65%–81%, $n = 82$) completed the full series of daily tests without interruption and a further 11% (95% CI: 6.3%–18%, $n = 12$) completed the series with an interruption, i.e., missed one or more days, but returned a result on the final day required. A total of 58 DCT participants (52%, 95% CI: 43%–61%) and two (7.4%, 95% CI: 2.1%–23%) non-participants completed the online survey. There was substantial variation between trusts (Table 1).

The characteristics of contacts who participated in DCT ($n = 111$) and those who declined ($n = 27$) were similar on most dimensions, with the exception of ethnicity. Black and minority ethnicity individuals (whose self-reported ethnicity was anything other than 'White British', 'White Irish', or 'White Other') made up a higher proportion of those who declined DCT (48%, 95% CI: 31%–66%, $n = 13$) than those who participated (38%, 95% CI: 29%–47%, $n = 42$).

Survey participants ($n = 60$) were broadly representative of all the pilot participants ($n = 138$), once the data were reviewed for missing data. Vaccination status was reported for 89 DCT participants (80%), of which 65 (73%) had received at least one dose of vaccine. In the survey, 40% of staff ($n = 24$) reported having had SARS-CoV-2 previously (Table 2).

Participants reported a total of 719 LFD results during the pilot period: a median of seven per participant (IQR = 6–7). Sixteen DCT participants (14.4%) reported more than seven results. One participant (0.9%; 95% CI: 0.2%-4.9%) tested positive on LFD during the testing period on day 3, which was confirmed by PCR. Three participants (2.7%; 95% CI: 0.9%-7.6%) tested positive on routine PCR during the DCT period, without developing symptoms or testing positive on LFD.

Table 1
DCT recruitment, participation and completion and survey response, by trust.

Eligible contacts	Trust 1	Trust 2	Trust 3	Trust 4	Trust 5	Total
	53	40	19	24	2	138
Quarantined (%)	3 (5.7)	17 (42.5)	4 (21.1)	2 (8.3)	1 (50.0)	**27 (19.6)**
Participated in DCT (%)	50 (94.3)	23 (57.5)	15 (78.9)	22 (91.7)	1 (50.0)	**111 (80.4)**
Completed DCT without interruption (%)	41 (82.0)	15 (65.2)	11 (73.3)	14 (63.6)	1 (100.0)	**82 (73.9)**
Completed DCT with interruption (%)	6 (12.0)	1 (4.3)	1 (6.7)	4 (18.2)	0 (0.0)	**12 (10.8)**
Did not complete DCT (%)	3 (6.0)	7 (30.4)	3 (20.0)	4 (18.2)	0 (0.0)	**17 (15.3)**
Survey responses						
Quarantining contacts (%)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)	0 (0.0)	**2 (7.4)**
DCT contacts (%)	32 (64.0)	3 (13.0)	8 (53.3)	15 (68.2)	0 (0.0)	**58 (52.3)**

In total, 28 interviews were conducted with trust staff: nine DCT leads, five DCT participants, four union representatives, and 10 IPC and contact-tracing leads. All trusts provided estimates of staff costs to set up and run the pilot.

Interview and survey findings

Operational feasibility

The DCT pilot was broadly welcomed by interviewed staff participants and trust DCT leads. Union representatives raised concerns that staff may have felt pressured to participate, about the legality of the quarantine exemption, and about the level of consultation. Ninety-three percent of survey respondents ($n = 54$) who participated in DCT said they were 'fairly positive' or 'very positive' about DCT and 97% ($n = 56$) said they would 'probably' or 'definitely' take part in DCT again.

Trust DCT leads reported that setting up the pilot was resource-intensive. However, all trusts had existing IPC, contact tracing, and testing functions, into which DCT was incorporated. The burden was reduced where templates and documentation were shared between trusts.

Table 2
Characteristics of DCT pilot participants and survey respondents.

		Eligible contacts				Survey respondents			
		DCT participants		Declined DCT		DCT participants		Declined DCT	
		Number	%	Number	%	Number	%	Number	%
Participants		111		27		58		2	
Sex	Male	33	30	1	4	19	33	1	50
	Female	54	49	3	11	39	67	1	50
	Unknown/not stated	24	22	23	85	0	0	0	0
Age (years)	18 to 24	7	6	1	4	2	3	0	0
	25 to 34	47	42	7	26	18	31	0	0
	35 to 44	21	19	4	15	9	16	1	50
	45 to 54	19	17	6	22	13	22	0	0
	55 to 64	14	13	1	4	12	21	1	50
	65 to 74	2	2	0	0	4	7	0	0
	Unknown/not stated	1	1	8	30	0	0	0	0
	Mean (SD)	38.6 (12.0)		39.6 (10.8)		–		–	
	Median (IQR)	35 (29–48.25)		38 (30–47)		–		–	
Ethnicity	Asian	16	14	5	19	5	9	0	0
	Black	12	11	3	11	5	9	0	0
	Mixed/Other	14	13	5	19	6	10	0	0
	White	67	60	6	22	42	72	2	100
	Unknown/not stated	2	2	8	30	0	0	0	0
Number in household	1	–		–		6	10	0	0
	2	–		–		19	33	0	0
	3–5	–		–		31	53	2	100
	6–9	–		–		2	3	0	0
Age of dependent children (years)	No children in household	–		–		29	50	1	50
	0–4	–		–		3	5	0	0
	5–10	–		–		8	14	0	0
	11–15	–		–		8	14	1	50
	16–18	–		–		11	19	0	0
	Prefer not to say	–		–		0	0	0	0
Job role	Clinical	99	89	14	52	51	88	1	50
	Non-clinical	12	11	5	19	6	10	0	0
	Unknown/not stated	0	0	8	30	1	2	1	50
Bank hours	Yes	–		–		7	12	0	0
	No	–		–		46	79	2	100
	Unknown/not stated	–		–		5	9	0	0
Vaccination status	Vaccinated	65	59	11	41	–		–	
	Unvaccinated	24	22	6	22	–		–	
	Unknown/not stated	22	20	10	37	–		–	
Known history of coronavirus	Yes	–		–		23	40	1	50
	No	–		–		28	48	1	50
	Unknown/not stated	–		–		7	12	0	0

Participation and adherence

In the survey, the most commonly cited reason for participation was the perceived ease of testing ($n = 34$, 59%). This perception was actualised; over 95% ($n = 55$) of participants rated their experiences of understanding instructions, swab-taking, speed of testing, and reading results, as either 'good' or 'very good'. In the survey, all DCT participants ($n = 58$) reported being at least 'fairly confident' that they conducted the test correctly.

Nineteen participants (33%) said they wanted to know whether they were infectious to protect family and friends. Twenty-one (36%) felt obliged to take part for employment reasons: 7 (12%) thought DCT was compulsory, 8 (14%) said they needed the pay, and 14 (24%) said their employer wanted them to do DCT.[1] Twelve (21%) said they participated because it would be hard for them to quarantine. Twenty-three (38%) also gave a free-text response (reported under 'other reasons for participating'), all of whom indicated a desire to keep working out of a sense of personal, professional, or institutional obligation.

In interviews, participants said many staff were already familiar with how to test and report LFD results as they were doing so routinely. Participants reported they received a high degree of one-to-one support from DCT pilot staff, which helped them to adhere to the testing regime. Staff reported testing at home was preferable to testing at work.

The main reasons interviewees gave for staff declining DCT were work fatigue leading to a preference for 10 days of quarantine, and scepticism over the performance of LFDs. Of the two survey respondents who did not participate in DCT, one did not meet the eligibility criteria, and the other gave no reasons for not participating, and reported that they would probably participate in DCT in future.

Behavioural impacts

Interviewed participants felt they were minimising the risk they posed to others by doing DCT. In survey responses, 45 of 53 participants (85%) reported thinking there was only 'a little' or 'hardly any' risk of passing the virus on to others the day after a negative test. Site and IPC leads reported that they observed no concomitant relaxation of IPC behaviours. Survey responses supported this: over 94% of DCT participants ($n = 50$) reported that their behaviour, in terms of leaving home and social mixing, did not change or became more cautious following a negative result. Sixty percent ($n = 35$) of DCT participants said that they would be 'somewhat' or 'much' more likely to disclose details of their contacts if they tested positive in future, if DCT was an alternative to quarantine.

Workplace infections

Although IPC leads at the pilot trusts acknowledged that their testing and contact tracing processes were not infallible, they expressed high confidence that any workplace transmission from DCT participants would have been detected. No such incidents were reported.

Strict IPC measures were already in place, the importance of which was emphasised to DCT participants, and there was an increasing rate of vaccination amongst HCWs. Consequently, trusts felt that the risk of onward transmission of SARS-CoV-2 in their settings was relatively low.

Workforce levels

Setting up the pilot required a median of 9 days per trust (IQR = 2.3–15), which equated to median gross pay costs of £2325 (IQR = £845-£4196). Running the pilot required a median of 9.4 days of staff time per week per trust (IQR = 1.4–10.8), which equated to median gross pay costs of £1475 (IQR = £359-£1882).

It was estimated that a total of 729 potential days of HCW work absence were averted, 88% of the maximum available (828). Ninety-one percent of these ($n = 660$) were for clinical staff. The estimated running cost per potential day of work absence averted was £50.

See Supplementary materials 3 and 4 for full survey results.

Discussion

This pilot of daily LFD testing in HCW in five trusts in England for 7 days following a SARS-CoV-2 exposure demonstrated an uptake rate of 80%. Eighty-two participants (74%) completed the full series of tests and 94 participants (85%) took a test on the final day of the DCT period, all but one of whom would have met the current criteria for successful completion of DCT (i.e. returning a negative result on day 7 and at least five negative results in total). The DCT pilot was widely viewed as acceptable by NHS trusts and staff as an alternative to quarantine. One potentially infectious participant (0.9%) was detected using LFD on day 3. Participating staff self-reported no relaxation of their IPC behaviours and no incidents of onward transmission were detected. Seven hundred twenty-nine potential days of HCW work absence were averted through participation in DCT in hospitals that were struggling to maintain critical services during the second peak of the SARS-CoV-2 pandemic.

DCT uptake in this pilot (80%) was higher than in the general public (50.1%) and schools (42.4%) studies. This is true even if the rates are adjusted by applying the more stringent schools definition of uptake: the comparable figure would have been below 35% in the general public pilot and 78% in this NHS pilot.[7,9] The higher uptake observed in our pilot may be attributable to HCWs' sense of obligation to keep working (a factor that was not evident in the general public pilot), and perception of ease of testing (59% of HCWs said DCT 'sounded easy to do', compared to 17% of the general public; presumably due to HCWs' pre-existing familiarity with LFD self-testing).[8,18] Recruitment and testing methods also differed between studies, and the NHS pilot combination of recruiting via existing administrative structures and testing at home may constitute optimal conditions.

A more concerning factor, that could have contributed to the high level of uptake, was the perception of pressure from employers on staff to participate in DCT. This is a potential problem for DCT in any workplace setting. Even if such perceptions are entirely unfounded, they could still erode staff trust.

The LFD positivity rate (0.9%) was similar to the apparent rate in the schools trial (1.0%; 32 of the 3166 available LFD-PCR pairs were LFD-positive), but noticeably lower than reported in the general public pilot (17.9%). This may be due to the exclusion of most or all household contacts from the NHS and school pilots, respectively, although lower prevalence of infection, and IPC measures and vaccination could have played a part.[7,9]

The lower effectiveness of LFDs to detect SARS-CoV-2 was highlighted by the three asymptomatic individuals who were PCR-positive but LFD-negative, but making direct comparisons between the two technologies is problematic.[19]

The evaluation found no evidence of onward transmission from DCT participants but it was not designed to quantify this risk, and the opportunity for transmission was limited by the small number of positives. We replicated the finding of the general public pilot that DCT would make people more likely to disclose details of their contacts.[8] This suggests DCT may have wider benefits for contact tracing that should be factored into future modelling, although the potential effect size needs quantifying.

[1] Numbers do not sum, as respondents could choose multiple responses.

Our finding that, following a negative LFD result, HCWs became more cautious with IPC and social mixing, runs counter to the general public pilot, where participants reported engaging in more non-essential activities.[8] This suggests DCT affects HCW behaviour in a unique way, which could be a reflection of their professional training and awareness of nosocomial transmission risks. There were, however, differences in the question phrasing in the two pilots, which could have led to divergent interpretations.

NHS settings have unique features that affect the balance of risks and benefits of DCT. On one hand is the risk of outbreaks, which could have grave consequences on vulnerable patients and jeopardise safe staffing levels. On the other hand, the risks of operating a DCT regime are mitigated by IPC measures, in-house contact tracing, local PCR testing, regular asymptomatic testing, and high vaccination rates, meaning that NHS settings are optimally positioned to implement DCT safely.[20–23]

For NHS trusts, the alternative to averting a frontline absence through DCT is to hire staff to cover the absence, which is not easy during a pandemic. The estimated DCT management cost of each averted absence (£50) was lower than the day rate of even the lowest-paid HCW (£69, based on a 7.5 h day and hourly rate of £9.21). This suggests that implementing DCT in frontline staff was cost-saving for trusts, and the saving may be greater for more senior staff and if the benefits of staff continuity are counted. However, the cost-benefit ratio would be more advantageous when more staff are identified as contacts, which is affected by factors such as prevalence, vaccination, circulating viral strains, and quarantine requirements. Furthermore, other factors beyond direct staffing costs must be considered by decision-makers, including LFD and PCR testing costs, staff time, and the impact of DCT on transmission.

Strengths and weaknesses

The short timeframe of the pilot enabled rapid generation of evidence for decision-making. The devolved delivery model allowed for variation in how DCT was experienced by participants in different trusts, providing real-world validity. However, the selected pilot trusts were experiencing particular operational pressures, and other trusts may not have the same motivation to deliver DCT.

The pilot did not have a predetermined statistical power, which limited the precision of the reported quantitative measures and precluded sub-group analyses. The absence of a control group meant we could not assess whether the number of cases detected by DCT was greater than the number that would have been detected anyway.

We had limited success in obtaining data from individuals who declined DCT. The consequent focus on those involved in administering or participating in the pilot poses a risk of bias. Furthermore, interviewees were recruited opportunistically, so they may not be representative.

The evaluation relied on workplace contact tracing teams for recruitment and monitoring. Therefore, some eligible participants may have been missed, increasing the risk of selection bias. Also, any transmission by DCT participants outside the workplace would not have been systematically detected.

Implications

Although at the time of writing, quarantine requirements have been relaxed, should this change, this pilot demonstrates the feasibility and acceptability of implementing DCT in acute NHS settings to avert unnecessary HCW absences. Potential concerns need to be anticipated and addressed, e.g., through consultation, informed consent processes and communications. Institutions could address concerns about employer pressure by assuring staff that the decision to participate (or not) in DCT will not affect their pay or employment. Trusts had confidence that the risk of transmission from DCT was low, and, had it occurred, would have been quickly identified. There remains a need to fully quantify the impact on SARS-CoV-2 transmission, to assess the trade-off between costs and benefits. The observed rates of DCT uptake and completion and the potential effect of DCT on willingness to disclose contacts should be used to inform future modelling.

Conclusion

This pilot suggests that a workplace-administered programme of daily LFD testing in NHS acute and ambulance services can be acceptably and feasibly operated to retain HCW contacts of SARS-CoV-2 who may otherwise be required to quarantine at home and not be available for work.

Author statements

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- Anita Jolly, Public Health Consultant, Public Health England

The pilot was substantially conceived and designed by ST and SF from NHS Test and Trace (T&T), and JS from NHS England and Improvement, with strategic direction and oversight provided by TF (T&T) and SH (T&T and Public Health England). The operationalisation of the pilot was coordinated by NS (T&T), and implemented, including collection of quantitative data, in NHS trusts by AR and SW (Royal Free

London), DH (Barts Health), Robert Bowen (London Ambulance Service), KJ (Oxford University Hospitals), and CW (Lancashire Teaching Hospitals). Qualitative data collection, verification and analysis was undertaken by GC, quantitative data verification and analysis was undertaken by AG (T&T). SB (T&T) repeated data verification, coordinated the evaluation report, and led on writing this paper. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethical approval

The pilot aimed to assess the feasibility of a wider roll-out of DCT. As such, a service evaluation approach was delivered and research ethics approval was not deemed necessary. Eligible individuals were informed about the pilot by trust DCT leads. Those who wanted to participate were consented at local organisational level. Participants were issued with a quarantine exemption letter from T&T. No personally identifiable information was collected, data were stored securely, and results were reported in a way to minimise the risk of deductive disclosure.

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Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf. JS was seconded from Great Ormond Street Hospital for Children NHS Trust to NHS England and NHS Improvement during the time the DCT pilot was taking place. TF received an honorarium to act as a panellist in the 2020 National Priorities Research Program 13-S programmatic review for the Qatar National Research Fund. SH is partially funded by the NIHR Health Protection Research Unit from Oxford and Imperial University for HCAI and AMR. The evaluation team, which was responsible for data analysis and writing the report, comprised staff from NHS Test and Trace who were employed by the UK Department of Health and Social Care (DHSC). The views expressed in this publication are those of the authors and not necessarily those of the National Health Service or DHSC.

Data sharing

Aggregated data are available and reported in the supplementary materials. No patient-level data can be shared, due to local information governance and data protection regulations.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2022.05.013.

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Short Communication

Are we suffering from the Peltzman effect? Risk perception among recovered and vaccinated people during the COVID-19 pandemic in Israel

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ABSTRACT

Objectives: The challenge of waning immunity and reinfection has been an acknowledged concern since the beginning of the COVID-19 pandemic. In the ongoing outbreak, reinfection rates are increasing alongside breakthrough cases among vaccinated individuals. The objective of this study was to examine the demographic characteristics associated with vaccination uptake among individuals previously infected with COVID-19 and to evaluate the period elapsed between the last vaccine dose and infection.
Study design: A retrospective-archive study was conducted.
Methods: Data were extracted from the Israeli Ministry of Health's open COVID-19 database.
Results: The study found that uptake of vaccination in previously infected individuals is relatively low. When examining gender, previously infected females were more likely to receive vaccination than previously infected males. Similarly, differences in vaccination uptake exist between age groups. When examining the interval between the last vaccine dose and infection, the most significant breakthrough infection rate was observed among individuals aged 20–59 years.
Conclusions: This study shows that there are specific populations subgroups that may serve as reservoirs of viral spread. Individuals in these groups may experience a false sense of security from a perceived sense of acquired long-term immunity, resulting in low levels of vaccine uptake and non-compliance with protective behaviours. Targeted messaging should be used to reemphasise the need for continued protective behaviours.

Introduction

COVID-19 has shown the impact that a novel, infectious pathogen can have on all facets of life for the global community.[1] Despite the implementation of numerous measures, employed to varying degrees of stringency by different authorities, COVID-19 continues to spread. In December 2020, in addition to various other countermeasures, the emergence of effective vaccines and the subsequent inoculation campaigns were integrated into the fight against the pandemic. Although COVID-19 mitigation measures have been shown to be effective in reducing morbidity and mortality rates, long-lasting flattening of the epidemic curve has not yet been achieved.[3] Acquired immunity on an individual level is established either through vaccination or natural pathogen infection. COVID-19 immunity has been challenged by virologically confirmed reinfection of previously infected individuals and vaccine breakthrough cases.[2]

The challenge of fading immunity and reinfection has been an acknowledged concern since the beginning of the COVID-19 pandemic. Findings from epidemiological analyses have reported natural immunity protection from reinfection for 6–12 months. Reinfection can occur when immunity wanes over time or the pathogen's antigenicity evolves, resulting in immune evasion.[3] Initially, it was uncertain whether individuals who had previously been infected would benefit from vaccination; however, subsequent findings have indicated that previously infected individuals would benefit from one vaccine dose.[4]

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The effectiveness of acquired immunity from the Pfizer BioNTech (BNT162b2) COVID-19 vaccine has demonstrated modest rates of breakthrough infection against the beta and delta COVID-19 variants, whereas other studies have reported higher rates.[5] Moreover, Goldberg et al.[6] indicated waning immunity a few months after receipt of a second inoculation dose. Thus, the present study aimed to (i) examine the demographic characteristics associated with vaccination uptake during the first year of an available vaccine in Israel among individuals who were previously infected with COVID-19 and (ii) evaluate the period elapsed between the last vaccine dose received (before infection) and infection. Given that reinfection and the emergence of novel variants have challenged the management of the ongoing COVID-19 pandemic, it is essential to determine which subgroups of the population have inadequate immunity.

Methods

A retrospective-archive study was conducted in Israel from 1 March 2020 to 31 December 2021. Data were obtained from the Israeli Ministry of Health's (MOH) open COVID-19 database. Data were also collected regarding the time elapsed between the last vaccine dose (adjusted to MOH guidelines) and infection.

First, an examination of the vaccination rates for the Pfizer BioNTech (BNT162b2) COVID-19 vaccine among previously infected and now recovered individuals, by the month of recovery, was conducted. For each confirmed patient, the vaccination status (yes or no) was examined from March 2020 to December 2021 (dynamic cohort).

Vaccination rates were compared by gender and by the following age groups: 0–19 years (n = 3,333,889); 20–59 years (n = 4,446,308); and ≥60 years (n = 1,509,562).

Non-vaccinated individuals are defined as those who did not receive any vaccine (or time of assessment was <1 week after their first dose). Patients with reinfection after vaccination were excluded from this part of the investigation (n = 182,611 [17%]).

Separately, for all recovered patients who were infected after vaccination, we measured the period elapsed between the patient's most recent vaccine dose (before infection) and the infection itself.

The examined periods defined for each dose were: 1st dose ≥20 days; 2nd and 3rd doses: 31–90 days and ≥3 months.

The rate of infected patients after receiving a specific dose in the specific periods were computed and stratified by age groups. The reinfection percentage from the beginning of the pandemic to the end of the study period was examined for vaccinated and unvaccinated individuals.

Results

From the onset of the pandemic until the end of December 2021, 1,392,144 people in Israel tested positive for COVID-19. Approximately 30% of the patients who were diagnosed with COVID-19 in March 2020 did not take up the offer of vaccination by the end of the study period (December 2021). This percentage of individuals receiving vaccination increased over the following months (i.e. for patients infected in April, May, June 2020 etc), where the percentage of receiving the first dose of vaccination among those previously infected during the first year of the pandemic was fairly stable and remained at approximately 40%. In a sub-analysis, when examining gender, the rate of immunisation among recovering females was higher than among males by 3–4% in the majority of months (see Fig. 1). In addition, immunisation rates were relatively low in young people (aged 0–19 years) compared with older age groups (aged 20–59 years and ≥60 years [data not shown]).

When examining the interval between vaccination and infection according to age group, relative to the population, the rate of infection was highest among the young population during the period of 20 days after the first dose of vaccination. Similarly, when examining the second dose of vaccination, the youngest population (aged 0–19 years) had the highest rate of infection between 1 month and 3 months following vaccination. Despite these results, the general population experiences a higher rate of infection 3 months following the second dose of vaccine. The most significant infection rate was observed among the age group 20–59 years, where 3.6% of all those vaccinated with the second vaccine dose were infected ≥3 months after vaccination. Among the age groups 0–19 years and ≥60 years, infection rates of 1.53% and 1.33%, respectively, were recorded for individuals who were infected ≥3 months following a second vaccine dose.

When investigating infection rates after the third booster dose, a similar but more moderate trend was found in the long-term follow-up (90 days after vaccination) when a higher incidence of infection was found in the 20–59 years and ≥60 years age groups. Three months after receiving the third vaccine dose, infection rates increase significantly among all age groups compared with the shorter periods examined; in particular, the 20–59 years age group has an infection rate of 0.29%, followed by 0.21% among individuals aged ≥60 years and 0.08% in the 0–19 years age group. It is important to note that infection rates 3 months after receiving the third vaccine dose are significantly lower than infection rates 3 months after receiving the second vaccine dose.

Discussion

The present study identified that uptake of vaccination following infection is relatively low among Israeli residents. While scientific understanding about natural infection-derived immunity is continuously emerging, findings have shown that vaccination can provide improved protection for previously infected individuals.[7] Furthermore, Kaim et al.[8] indicated that previously infected individuals were also less compliant with additional protective health behaviours (e.g. mask wearing and social distancing), rendering this population group a significant potential reservoir of viral spread. Previously infected individuals who successfully recover may have a diminished perceived health risk and perceived severity of the virus. As risk perception and perceived severity have been shown to play an important role in adherence to protective behaviours, these individuals may be less likely to comply.[9] Current literature shows that novel risks, such as the COVID-19 pandemic, often induce fear; however, repeated exposure to the risk may result in risk underestimation and reduced compliance with protective health behaviours.[10] Consistent with studies on vaccine hesitancy, younger age was observed to be a predictor for lower vaccine uptake; however, the current findings relating to gender were inconsistent with previous results, where lower vaccine uptake was often observed among women.

The trends of infection suggest that individuals in the 20–59 years age group may serve as a critical potential source of viral spread, despite data concentrating on individuals who have been vaccinated. The results indicate the possibility that this population group may also become less vigilant about protective behaviours and engage in more risky behaviours, as described by the Peltzman effect.[11]

The present study reveals insights from the COVID-19 global pandemic. Specifically, this study emphasises the importance of improved public communication strategies for promoting uptake of protective health behaviours and emphasising the necessity of continued vigilance in behaviour during times of crises. The current

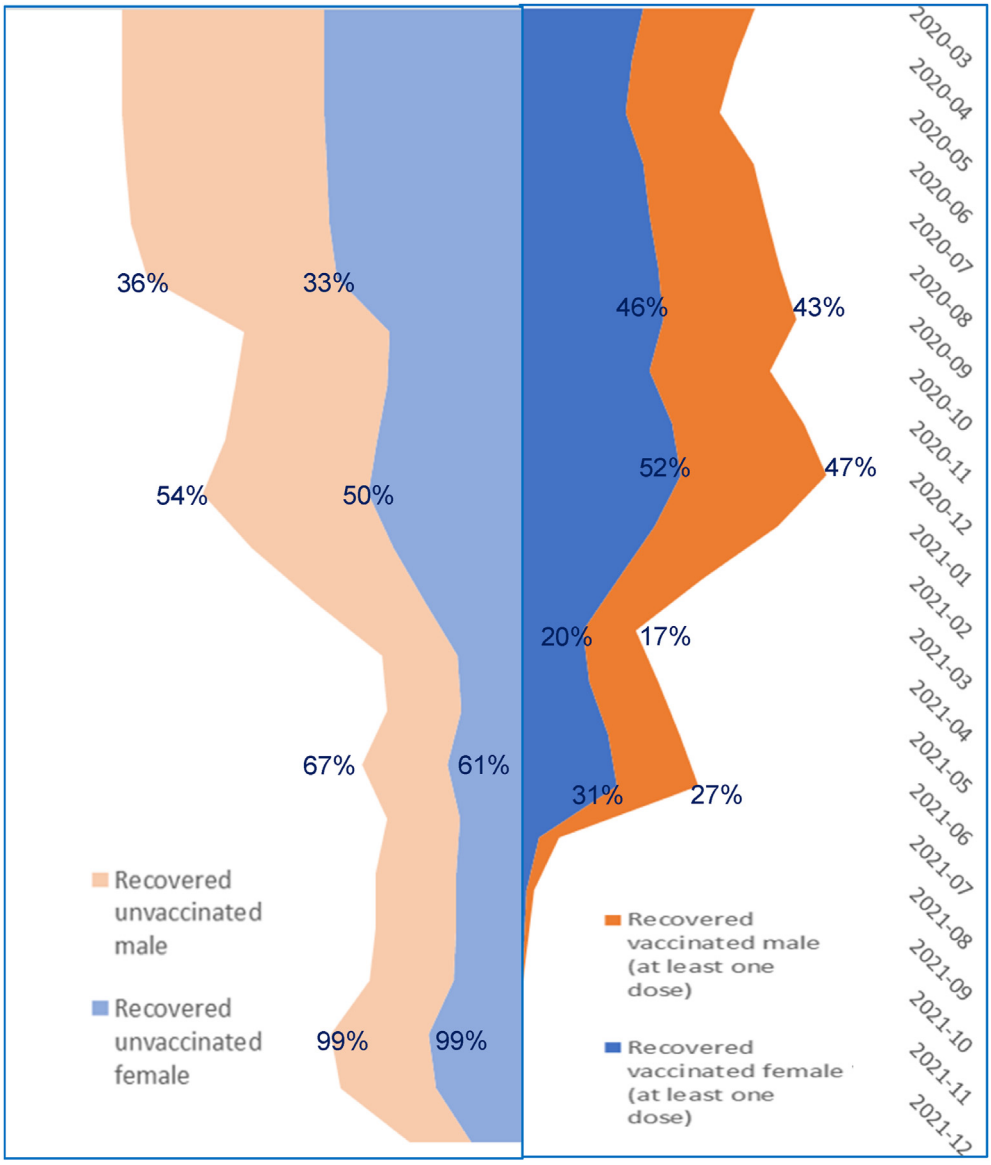

Fig. 1. Per month of infection (year-month), percentage of recovered patients according to number of vaccine doses received. Notes: Gender percentages for each are denoted in blue (male) and orange (female). In addition, patients with reinfection after vaccination are excluded in this figure. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article).

findings highlight the importance of targeting risk communication and information messaging to specific population subgroups. Specifically, the current results indicate that those of younger age, unvaccinated and non-booster vaccinated individuals should be targeted with different risk communication strategies that take into consideration the unique beliefs and features of each group.[12] Messages need to be adapted to accommodate specific concerns and hesitations demonstrated by these distinct population subgroups.

Author statements

Ethical approval

Ethical approval was not required since all data used in this study were obtained from the publicly available open COVID database website, https://datadashboard.health.gov.il/COVID-19/general. No individual data were included in the study.

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Competing interests

None declared.

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Original Research

Child and adolescent COVID-19 vaccination status and reasons for non-vaccination by parental vaccination status☆

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ABSTRACT

Objectives: COVID-19 vaccines are recommended for children ages ≥5 years. To develop effective interventions to increase uptake, this study explores reasons for parental hesitancy of child and adolescent COVID-19 vaccination.

Study design: The Household Pulse Survey (HPS) is a nationally representative cross-sectional online household survey of adults aged ≥18 years that began data collection in April 2020 to help understand household experiences during the COVID-19 pandemic.

Methods: Using data from December 29, 2021, to January 10, 2022 (n = 11,478), we assessed child and adolescent COVID-19 vaccination coverage and parental intent to vaccinate their children and adolescents. Factors associated with child and adolescent vaccination coverage were examined using multivariable regression models. Reasons for not having had their child or adolescent vaccinated, stratified by parental vaccination status, were compared using tests of differences in proportions.

Results: Less than one-half (42.3%) of children and three-quarters (74.8%) of adolescents are vaccinated. Vaccination coverage was lower among households with lower education, as well as among children who had not had a preventive check-up in the past year. Parents of unvaccinated children were more likely to report that they do not trust COVID-19 vaccines, do not trust the government, and do not believe children need a COVID-19 vaccine compared to parents of vaccinated children.

Conclusion: Efforts to increase uptake of vaccines by children and adolescents should target those with lower education, reassure parents of the vaccine safety and efficacy for themselves and their children/adolescents, and support yearly preventive care visits for their children.

Introduction

While COVID-19 vaccines in the United States were authorized for adolescents (ages 12–17 years) since May 2021,[1] and for children (ages 5–11 years) since November 2021,[2] vaccination among these age groups remains low, despite the vaccine being free of charge. Data collected from January 2–29, 2022, in the Centers for Disease Control and Prevention (CDC) National Immunization Survey-Child COVID-19 Module, found that only 28% of children ages 5–11 years, and 65% of adolescents ages 12–17 years had received at least one dose of the COVID-19 vaccine.[3] Moreover, 19–31% of parents of children in these age groups reported that they would probably not or definitely not vaccinate their children.[3] However, reasons for parental hesitancy about vaccinating their children and adolescents for COVID-19 are not well understood.

Throughout the winter of 2021–2022, COVID-19 cases and hospitalizations among children reached the highest prevalence since the pandemic started, possibly due to the emergence of the highly transmissible Omicron variant.[4,5] For example, COVID-19 cases among US children in early January 2022 were triple the number of cases at the end of December 2021.[5] Approximately 8.5 million children have tested positive for COVID-19 since the start of

☆ The data that support the findings of this study are openly available at https://www.census.gov/programs-surveys/household-pulse-survey/datasets.html.

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the pandemic, which may have immediate as well as long-lasting impacts on children's physical, mental, and social well-being.[5] Furthermore, COVID-19 ranks as one of the top 10 causes of death for children ages 5–11 years.[6]

Despite vaccine recommendations and demonstrated benefits of vaccinating children and adolescents for COVID-19, many parents remain hesitant.[7] Previous studies have found that some parents are hesitant about routine child and adolescent vaccinations, such as diphtheria, tetanus toxoid, and acellular pertussis, measles, mumps, and rubella, human papillomavirus, and influenza vaccines.[8–10] However, comparatively, the prevalence of non-vaccination against routine child and adolescent illnesses is much lower than it is against COVID-19, suggesting that parents are more hesitant about COVID-19 vaccines than routine childhood vaccines. The limited published research on this issue shows that the primary reason for parents not intending to vaccinate children/adolescents is due to concerns regarding vaccine safety and potential adverse effects of the vaccine.[11–14] Moreover, some parents may be hesitant to get themselves vaccinated for COVID-19, which may carry over to their hesitancy toward child and adolescent COVID-19 vaccines.

The objective of this study was to assess child and adolescent COVID-19 vaccine coverage and parental intent to vaccinate their children and adolescents, factors associated with child and adolescent vaccination coverage, and reasons for non-vaccination using a large, nationally representative survey of US households. It is hypothesized that parents who are hesitant to be vaccinated themselves, due to concerns about safety or efficacy, may also have the same concerns for not vaccinating their children. We compared reasons for non-vaccination among parents with non-vaccination of their children. Understanding factors that are associated with child and adolescent vaccination coverage, as well as reasons why parents are not vaccinating their children/adolescents, is critical for improving uptake in these groups.

Methods

Study design

The Household Pulse Survey (HPS) is a nationally representative cross-sectional online household survey of adults aged ≥18 years. The survey is conducted by the United States Census Bureau in collaboration with 11 other federal agencies to help understand household experiences during the COVID-19 pandemic. The survey design of the HPS has been described previously.[15] Briefly, the HPS uses the Census Bureau's Master Address File (MAF), which has approximately 140,000,000 valid housing units in the USA, to select a sample large enough to provide representative estimates at the national, state, and local level for 15 Metropolitan Statistical Areas. To rapidly deploy the survey, the HPS uses an Internet and telephone interview system by pairing email and mobile telephone numbers from the Census Bureau Contact Frame with addresses in the MAF, for which there were 80% matches. Unique phone numbers and email addresses were identified and assigned to only one housing unit. The housing units in the MAF were limited to these addresses on the Contact Frame as the final eligible housing units for the HPS.

Newly sampled households were contacted by email and/or text, depending on availability. All non-institutionalized adults aged ≥18 years in the USA were eligible for the study. The survey was conducted online using Qualtrics as the data collection platform. All questions underwent expert and subject matter review at the Census Bureau and partner agencies, as well as cognitive testing laboratories at the Bureau of Labor Statistics and the National Center for Health Statistics. These questions are also similar to questions that were added to other national surveys, such as the National Immunization Survey-Adult COVID Module, which is conducted by the CDC.[16] Data collection began in April 2020, with at least one data collection cycle during each month, and approximately 75,000 participants in each data collection cycle. Data collected from December 29, 2021, to January 10, 2022 (response rate = 5.8%) were used in this study.[17,18]

This study included only respondents (hereafter referred to as 'parents') with children ages 5–11 years only or 12–17 years only living in the household ($n = 11{,}478$). This study was reviewed by the Tufts University Health Sciences Institutional Review Board and determined as not human subjects research (study ID: 00002308).

Variables

To determine the existence and number of children in each household, respondents were asked: 'In your household, are there … Children under 5 years old? Children 5 through 11 years old? Children 12 through 17 years old?' The analyses were restricted to households that had children ages 5–11 years or 12–17 years. This was done to allow the analysis of the differences between the factors associated with vaccination status for children (aged 5–11 years) and adolescents (aged 12–17 years) as the survey did not ask to which child(ren) answers to questions applied. Among households with children, respondents were asked: 'Have any of the children living in your household received at least one dose of a COVID-19 vaccine?' [yes/no/don't know]. Among those who did not answer 'no,' respondents were asked about their intent to vaccinate children: 'Now that vaccines to prevent COVID-19 are available to most children, will the parents or guardians of children in your household …' Response options were definitely, probably, be unsure about, probably not, or definitely not get the children a vaccine, or 'I do not know the plans for vaccination of children living in my household.' Those who responded they would 'definitely' or 'probably' vaccinate their children were combined and referred to as 'intent to vaccinate' and those who stated that they would 'definitely not' or 'probably not' vaccinate their children were combined and referred to as 'reluctant to vaccinate.'

Among respondents who had not already vaccinated their child(ren) and did not 'definitely plan' to get their child(ren) vaccinated or did not answer that they did not know the vaccination plans for children, respondents were asked reasons for not getting children vaccinated. They were asked: 'Which of the following, if any, are reasons that the parents or guardians of children living in your household [only probably will/probably won't/definitely won't/are unsure about whether to] get a COVID-19 vaccine for the children?' Response options, for which respondents could select all that applied, were as follows: 1) concern about possible side-effects of a COVID-19 vaccine for children; 2) plan to wait and see if it is safe and may get it later, 3) not sure if a COVID-19 vaccine will work for children, 4) don't believe children need a COVID-19 vaccine, 5) the children in this household are not members of a high-risk group, 6) the children's doctor has not recommended it, 7) don't trust COVID-19 vaccines, 8) don't trust the government, and 9) other. Additional response options included the following and were recorded as 'other' due to the small number of responses: 1) other people need it more than the children in this household do right now, 2) concern about missing work to have the children vaccinated, 3) unable to get a COVID-19 vaccine for children in this household, 4) parents or guardians in this household do not vaccinate their children, 5) concern about the cost of a COVID-19 vaccine, and 6) other.

Table 1
Characteristics of parents with children aged 5–11 years and adolescents aged 12–17 years, Household Pulse Survey, December 29, 2021–January 10, 2022.

	Parents of children aged 5–11 years ($n = 4577$)			Parents of adolescents aged 12–17 years ($n = 6901$)		
	Unweighted *n*	%	95% CI	Unweighted *n*	%	95% CI
Age group (in years)						
18–29	259	14.9	(12.2, 17.6)	308	17.0	(14.5, 19.5)
30–39	1554	32.7	(30.4, 35.0)	707	11.5	(10.1, 12.9)
40–49	1948	33.1	(31.2, 35.0)	3072	37.1	(35.0, 39.2)
50–64	645	14.8	(13.0, 16.6)	2493	29.2	(27.1, 31.3)
65+	171	4.6	(3.4, 5.7)	321	5.2	(4.3, 6.1)
Gender						
Men	1610	45.8	(43.7, 47.9)	2333	47.3	(44.6, 49.9)
Women	2884	54.2	(52.1, 56.3)	4454	52.7	(50.1, 55.4)
Race/ethnicity						
Hispanic	634	24.1	(21.4, 26.7)	934	24.8	(22.5, 27.2)
Non-Hispanic Asian	357	7.6	(6.3, 8.9)	447	5.7	(4.9, 6.5)
Non-Hispanic black	461	14.6	(13.1, 16.0)	646	11.2	(9.9, 12.6)
Non-Hispanic white	2918	50.1	(47.3, 52.9)	4601	55.1	(53.2, 57.0)
Non-Hispanic other/multiracial	207	3.6	(2.9, 4.3)	273	3.1	(2.5, 3.8)
Educational attainment						
High school equivalent or less	626	38.8	(35.9, 41.7)	986	39.2	(37.1, 41.3)
Some college or Associate's degree	1368	30.2	(28.2, 32.3)	2235	32.9	(31.0, 34.7)
Bachelor's degree	1286	15.3	(14.1, 16.6)	1891	14.5	(13.3, 15.6)
Graduate degree	1297	15.6	(14.3, 16.9)	1789	13.5	(12.6, 14.4)
Annual household income						
<$35,000	673	19.1	(16.7, 21.5)	1018	17.9	(16.3, 19.6)
$35,000-$49,999	351	10.9	(9.2, 12.7)	549	8.7	(7.5, 10.0)
$50,000-$74,999	555	11.2	(9.6, 12.8)	815	14.1	(12.3, 15.9)
≥$75,000	2234	35.4	(33.1, 37.7)	3382	38.0	(36.1, 39.9)
Did not report	764	23.4	(20.6, 26.2)	1137	21.3	(19.3, 23.3)
Health insurance status						
Insured	3816	90.0	(87.7, 92.3)	5803	90.9	(89.1, 92.7)
Not insured	222	10.0	(7.7, 12.3)	338	9.1	(7.3, 10.9)
Parental history of COVID-19 infection						
Yes	1153	30.3	(27.4, 33.3)	1765	28.7	(26.3, 31.1)
No	3334	69.7	(66.7, 72.6)	4971	71.3	(68.9, 73.7)
Parental vaccination status						
Yes	3962	81.4	(54.9, 60.4)	6077	84.2	(82.3, 86.0)
No	613	18.6	(16.2, 20.9)	817	15.8	(14.0, 17.7)
US region						
Northeast	772	14.9	(13.4, 16.4)	1187	16.9	(15.1, 18.7)
Midwest	948	19.0	(17.0, 21.1)	1366	19.5	(17.6, 21.4)
South	1488	41.4	(38.6, 44.2)	2316	40.3	(38.2, 42.4)
West	1369	24.7	(22.2, 27.2)	2032	23.2	(21.2, 25.3)

Note: All percentages and confidence intervals are weighted to the US population.

Independent variables

Sociodemographic factors assessed for parents of children ages 5–11 years and 12–17 years were respondent age group [18–29, 30–39, 40–49, 50–64, ≥65 years], gender [men, women], race/ethnicity [Hispanic, non-Hispanic (NH) Asian, NH Black, NH White, NH other/multiracial], educational attainment [high school equivalent or less, some college or Associate's degree, Bachelor's degree, graduate degree], annual household income [<$35000, $35000–49999, $50000–74999, ≥$75000, did not report], health insurance status [covered, not covered], parent COVID-19 vaccination status [vaccinated with ≥1 dose, not vaccinated], parental

Table 2
Parental intent for vaccinating children and adolescents, by parental COVID-19 vaccination status, Household Pulse Survey, December 29, 2021–January 10, 2022.

	Overall			Vaccinated parents		Unvaccinated parents		Prevalence difference	
	Unweighted *n*	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Children aged 5–11 years									
Vaccinated	2397	42.3	(39.6, 45.1)	50.8	(47.8, 53.9)	5.1	(2.1, 8.2)	45.7	(41.3, 50.2)*
Definitely/probably will vaccinate	763	21.8	(18.7, 24.8)	23.8	(20.7, 26.8)	13.1	(6.5, 19.7)	10.6	(4.2, 17.1)*
Unsure	423	10.5	(8.9, 12.1)	9.0	(7.7, 10.3)	17.2	(11.6, 22.8)	−8.2	(−13.8, −2.5)*
Definitely will not/probably will not vaccinate	818	19.0	(16.8, 21.2)	10.8	(8.9, 12.7)	54.8	(45.8, 63.8)	−44.1	(−53.1, −35.0)*
Don't know vaccination plans	176	6.4	(4.8, 8.0)	5.6	(4.1, 7.2)	9.8	(4.9, 14.7)	−4.1	(−9.3, 1.0)
Adolescents aged 12–17 years									
Vaccinated	5379	74.8	(72.6, 77.0)	86.2	(84.5, 87.9)	14.1	(8.8, 19.4)	72.1	(66.6, 77.6)*
Definitely/probably will vaccinate	320	5.5	(4.4, 6.7)	5.5	(4.3, 6.7)	5.8	(3.1, 8.5)	−0.3	(−3.1, 2.5)
Unsure	237	3.9	(2.9, 4.8)	2.3	(1.7, 2.9)	12.3	(7.6, 17.0)	−10.0	(−14.7, −5.4)*
Definitely will not/probably will not vaccinate	802	12.6	(11.3, 13.9)	3.9	(3.2, 4.6)	59.0	(53.5, 64.4)	−55.1	(−60.5, −49.6)*
Don't know vaccination plans	163	3.2	(2.4, 4.0)	2.1	(1.5, 2.8)	8.8	(4.9, 12.7)	−6.7	(−10.7, −2.7)*

Note: All percentages and confidence intervals are weighted to the US population.
*$P < 0.05$.

Table 3
Prevalence of and factors associated with child and adolescent COVID-19 vaccination, Household Pulse Survey, December 29, 2021–January 10, 2022.

	Child vaccination (aged 5–11 years)				Adolescent vaccination (aged 12–17 years)			
	%	95% CI	aPR[a]	95% CI	%	95% CI	aPR[a]	95% CI
Overall	42.3	(39.6, 45.1)			74.8	(72.6, 77.0)		
Respondent variables:								
Age group (in years)								
18-29 (reference)	36.5	(26.3, 46.7)	1.00	–	80.9	(74.5, 87.3)	1.00	–
30-39	35.7	(31.5, 39.9)	1.07	(0.73, 1.56)	59.6	(51.7, 67.5)	0.82	(0.72, 0.94)
40-49	51.7	(47.6, 55.9)	1.32	(0.91, 1.94)	74.0	(71.2, 76.8)	0.95	(0.89, 1.01)
50-64	40.4	(34.5, 46.2)	1.07	(0.74, 1.54)	78.9	(76.4, 81.5)	0.93	(0.87, 1.00)
65+	47.2	(33.7, 60.8)	1.36	(0.88, 2.09)	70.6	(60.6, 80.7)	0.84	(0.72, 0.97)
Gender								
Men	45.7	(41.6, 49.8)	1.07	(0.96, 1.18)	76.8	(73.3, 80.3)	1.06	(1.01, 1.10)
Women (reference)	40.1	(36.9, 43.3)	1.00	–	73.3	(70.9, 75.7)	1.00	–
Race/ethnicity								
Hispanic	38.8	(32.4, 45.3)	1.20	(1.01, 1.42)	81.3	(77.4, 85.2)	1.05	(0.99, 1.12)
Non-Hispanic Asian	71.8	(62.6, 81.1)	1.12	(1.01, 1.24)	95.0	(92.5, 97.5)	1.07	(1.03, 1.12)
Non-Hispanic black	32.4	(26.5, 38.3)	0.97	(0.80, 1.18)	72.4	(65.6, 79.2)	1.03	(0.95, 1.11)
Non-Hispanic white (reference)	42.6	(39.7, 45.5)	1.00	–	70.5	(68.0, 72.9)	1.00	–
Non-Hispanic other/multiracial	40.4	(31.2, 49.5)	1.01	(0.81, 1.25)	70.9	(63.4, 78.5)	1.04	(0.96, 1.12)
Educational attainment								
High school equivalent or less (reference)	29.5	(24.6, 34.5)	1.00	–	66.4	(61.4, 71.4)	1.00	–
Some college or Associate's degree	39.7	(35.5, 43.9)	1.11	(0.90, 1.37)	75.1	(72.1, 78.1)	1.04	(0.99, 1.11)
Bachelor's degree	51.7	(47.5, 55.9)	1.18	(0.99, 1.42)	84.3	(81.9, 86.7)	1.08	(1.01, 1.15)
Graduate degree	70.0	(65.8, 74.2)	1.47	(1.23, 1.76)	88.3	(86.0, 90.7)	1.11	(1.04, 1.19)
Annual household income								
<$35,000 (reference)	30.1	(23.5, 36.6)	1.00	–	67.6	(61.6, 73.6)	1.00	–
$35,000-$49,999	30.3	(21.4, 39.3)	0.83	(0.57, 1.22)	71.9	(64.7, 79.1)	1.02	(0.91, 1.15)
$50,000-$74,999	37.2	(30.6, 43.8)	1.00	(0.73, 1.38)	73.0	(65.7, 80.4)	1.05	(0.95, 1.16)
≥$75,000	57.4	(53.9, 61.0)	1.15	(0.91, 1.46)	81.1	(78.5, 83.7)	1.06	(0.97, 1.15)
Did not report	37.6	(30.3, 44.9)	0.96	(0.64, 1.45)	71.9	(67.5, 76.4)	1.10	(0.98, 1.23)
Health insurance								
Insured (reference)	45.5	(42.4, 48.7)	1.00	–	77.2	(74.9, 79.5)	1.00	–
Not insured	21.0	(12.2, 29.8)	0.72	(0.49, 1.07)	60.1	(51.0, 69.2)	0.92	(0.82, 1.05)
Parental history of COVID-19 infection								
Yes (reference)	27.9	(23.7, 32.1)	1.00	–	68.3	(64.2, 72.4)	1.00	–
No	48.2	(45.0, 51.3)	1.34	(1.15, 1.55)	77.6	(75.3, 80.0)	1.04	(0.99, 1.10)
Parental COVID-19 vaccination status								
Yes	50.8	(47.8, 53.9)	7.79	(3.69, 16.46)	86.2	(84.5, 87.9)	5.15	(3.41, 7.78)
No (reference)	5.1	(2.1, 8.2)	1.00	–	14.1	(8.8, 19.4)	1.00	–
US region								
Northeast (reference)	52.1	(45.4, 58.7)	1.00	–	81.6	(77.0, 86.3)	1.00	–
Midwest	42.0	(37.1, 46.9)	1.01	(0.86, 1.18)	71.0	(66.6, 75.3)	0.95	(0.89, 1.02)
South	33.2	(29.4, 37.1)	0.79	(0.69, 0.90)	71.3	(67.5, 75.1)	0.94	(0.89, 0.99)
West	52.0	(46.2, 57.8)	1.06	(0.93, 1.21)	79.0	(75.4, 82.7)	0.98	(0.93, 1.03)
Child/Adolescent variables:								
School type								
Public only (reference)	41.5	(38.6, 44.5)	1.00	–	75.3	(72.9, 77.7)	1.00	–
Private only	61.5	(55.4, 67.6)	1.09	(0.97, 1.22)	75.0	(64.9, 85.0)	0.97	(0.91, 1.03)
Other — combined, homeschooled, none	39.4	(32.6, 46.2)	0.94	(0.80, 1.11)	71.9	(65.4, 78.4)	0.99	(0.92, 1.06)
Preventive check-up								
Yes	46.8	(43.4, 50.2)	1.18	(1.02, 1.37)	79.3	(76.8, 81.9)	1.09	(1.04, 1.15)
Some	33.5	(20.0, 47.0)	0.95	(0.63, 1.44)	73.2	(62.1, 84.3)	1.06	(0.95, 1.18)
None (reference)	32.8	(27.9, 37.7)	1.00	–	68.5	(64.3, 72.6)	1.00	–

Note: All percentages and confidence intervals are weighted to the US population.
Abbreviations: aPR = adjusted prevalence ratio; CI = confidence interval.
[a] Model adjusted for age group, gender, race/ethnicity, educational attainment, annual household income, health insurance status, parental history of COVID-19 infection, parent COVID-19 vaccination status, region, child school type, and child preventive check-up in the past year.

history of COVID-19 infection [yes, no], child preventive check-ups in the past year [all, some, none of children in the household], child school type [only public school, only private school, other (including combination of school types, homeschooling, and no school) for children in the household], geographic region [Northeast, Midwest, South, and West].

Statistical analysis

Sociodemographic characteristics of parents of children ages 5–11 years and 12–17 years were assessed. Child and adolescent COVID-19 vaccination coverage and parental intentions regarding vaccinating their children were assessed overall and stratified by parental COVID-19 vaccination status. Differences in child and adolescent COVID-19 vaccination and parental intentions to vaccinate their children between vaccinated and unvaccinated parents were assessed. Parents who have children in both age groups (5–11 and 12–17 years) were excluded from the analyses because it could not be determined which child the parent referred to for the childhood vaccination questions ($n = 4069$). Factors associated with child and adolescent vaccination coverage were examined using multivariable regression models. Independent variables in the model included age group, gender, race/ethnicity, educational attainment, annual household income, health insurance status, parental history of COVID-19 infection, parental COVID-19 vaccination status, geographic region, child school type, and child

preventive check-up in the past year. Reasons for not getting their child and adolescents vaccinated, stratified by parental vaccination status, were compared using tests of differences in proportions. An ecologic association between state-level parental vaccination coverage and child/adolescent vaccination coverage was also assessed using linear regression. All results presented discussed in the text (though not necessarily tables) are statistically significant at $P < 0.05$. Analyses accounted for the survey design and weights to ensure a representative sample in SAS (version 9.4; SAS Institute, Inc.) and Stata (version 16.1).

Results

There were 4577 parents with children ages 5–11 years and 6901 parents with adolescents ages 12–17 years (Table 1). Approximately 81–84% of parents of children and adolescents were vaccinated against COVID-19. Overall, 42.3% of children and 74.8% of adolescents were vaccinated (Table 2). Among all children and adolescents, over a fifth (21.8%) of parents intended to vaccinate their child, and 5.5% intended to vaccinate their adolescent. On the other hand, 19.0% and 12.6% parents of children and adolescents, respectively, were reluctant about vaccinating their children. Childhood vaccination status also differed by parental vaccination status. Among vaccinated parents, 50.8% of children were vaccinated compared to 5.1% of children among unvaccinated parents (prevalence difference = 45.7, 95% CI: 41.3, 50.2). Similarly, among adolescents, 86.2% were vaccinated compared to 14.1% of adolescents among unvaccinated parents (prevalence difference = 72.1, 95% CI: 66.6, 77.6). Unvaccinated parents were also more likely to be reluctant toward childhood vaccination. For example, 54.8% and 59.0% of unvaccinated parents of children and adolescents, respectively, were reluctant about vaccinating their children, whereas only 10.8% and 3.9% of vaccinated parents were reluctant toward childhood vaccinations.

Factors associated with child COVID-19 vaccination included being non-Hispanic Asian (adjusted prevalence ratio [aPR] = 1.12, 95% confidence interval [CI]: 1.01–1.24), Hispanic (aPR = 1.20, 95% CI: 1.01–1.42), having a graduate degree (aPR = 1.47, 95% CI: 1.23–1.76), never having a previous parental history of COVID-19 infection (aPR = 1.34, 95% CI: 1.15–1.55), having child preventive check-ups in the past year (aPR = 1.18, 95% CI: 1.02–1.37), and the parent being vaccinated against COVID-19 (aPR = 7.79, 95% CI: 3.69–16.46) (Table 3). Similarly, factors associated with adolescent COVID-19 vaccination included being non-Hispanic Asian (aPR = 1.07, 95% CI: 1.03–1.12), having a Bachelor's (aPR = 1.08, 95% CI: 1.01–1.15) or graduate degree (aPR = 1.11, 95% CI: 1.04–1.19), and parent being vaccinated against COVID-19 (aPR = 5.15, 95% CI: 3.41–7.78) having child preventive check-ups in the past year (aPR = 1.09, 95% CI: 1.04–1.15) (see Table 3).

Reasons for not vaccinating children and adolescents differed by parental vaccination status (Fig. 1). Although the main reason for not vaccinating children was concern about possible side-effects among vaccinated parents (63.6%) and unvaccinated parents (62.4%), a higher percentage of vaccinated parents planned to wait and see (45.5%) compared to unvaccinated parents (32.9%). On the other hand, a higher proportion of unvaccinated parents did not trust COVID-19 vaccines (41.1%), did not trust the government (31.3%), and did not believe children need a COVID-19 vaccine (28.0%), compared to vaccinated parents (11.9%, 14.5%, and 18.0%, respectively see Table 4). Similarly, the main reasons for not

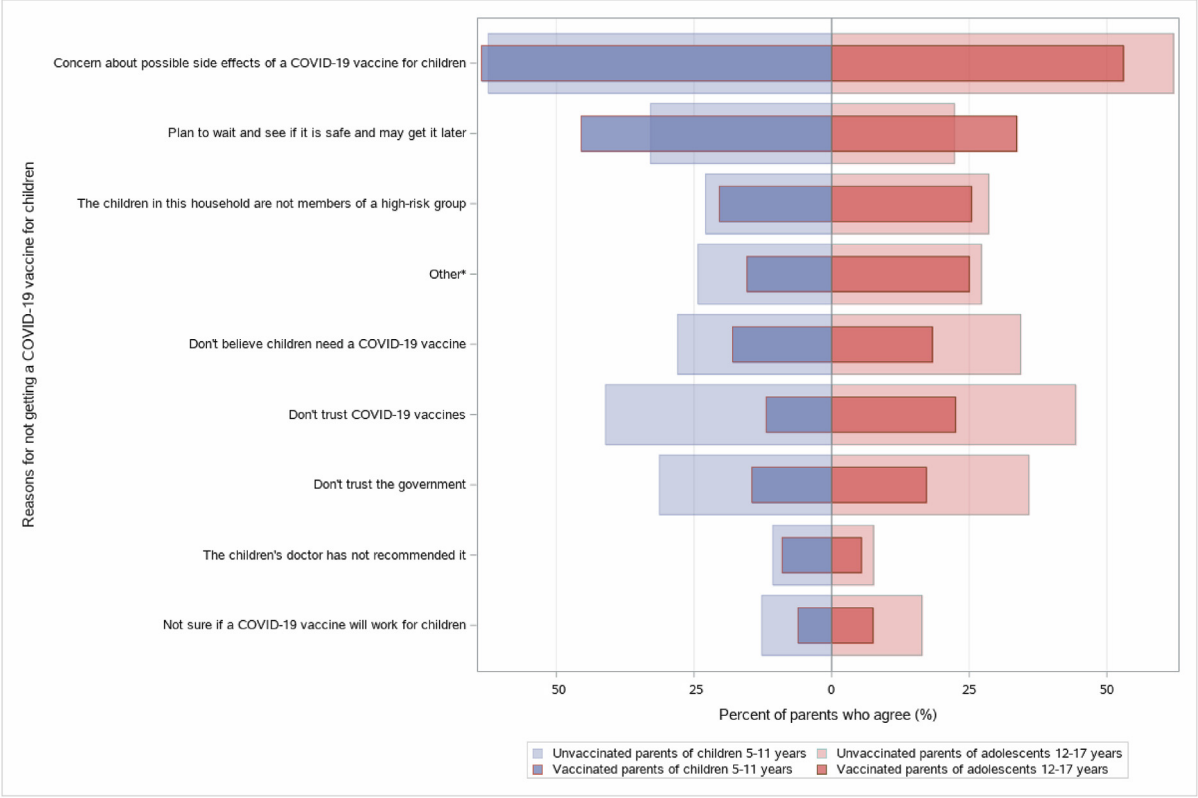

Fig. 1. Reasons for not vaccinating children and adolescents for COVID-19, by parental vaccination status, Household Pulse Survey, December 29, 2021–January 10, 2022. *Other category includes 1) other people need it more than the children in this household do right now, 2) concern about missing work to have the children vaccinated, 3) unable to get a COVID-19 vaccine for children in this household, 4) parents or guardians in this household do not vaccinate their children, 5) concern about the cost of a COVID-19 vaccine, and 6) other.

Table 4
Reasons for not vaccinating children and adolescents for COVID-19, by parental vaccination status, Household Pulse Survey, December 29, 2021–January 10, 2022.

	Children aged 5–11 years						Adolescents aged 12–17 years					
	Vaccinated parents			Unvaccinated parents			Vaccinated parents			Unvaccinated parents		
	Unweighted *n*	%	95% CI	Unweighted *n*	%	95% CI	Unweighted *n*	%	95% CI	Unweighted *n*	%	95% CI
Concern about possible side-effects of a COVID-19 vaccine for children	652	63.6	(57.9, 69.3)	329	62.4	(55.8, 69.0)	317	53.0	(45.9, 60.1)	393	62.1	(56.0, 68.2)
Plan to wait and see if it is safe and may get it later	518	45.5	(40.2, 50.8)[a]	136	32.9	(26.2, 39.6)	209	33.6	(27.8, 39.4)[a]	142	22.3	(17.6, 27.0)
Not sure if a COVID-19 vaccine will work for children	92	6.1	(4.3, 7.8)[a]	75	12.7	(7.8, 17.5)	44	7.5	(4.3, 10.8)[a]	88	16.4	(11.2, 21.6)
Don't believe children need a COVID-19 vaccine	202	18.0	(14.0, 21.9)[a]	193	28.0	(22.2, 33.7)	104	18.3	(13.3, 23.3)[a]	232	34.3	(27.6, 41.0)
The children in this household are not members of a high-risk group	281	20.4	(16.1, 24.7)	167	22.9	(18.6, 27.2)	155	25.4	(20.6, 30.2)	215	28.5	(22.7, 34.2)
The children's doctor has not recommended it	93	9.0	(5.7, 12.3)	72	10.7	(6.7, 14.8)	43	5.4	(3.2, 7.7)	71	7.6	(4.9, 10.3)
Don't trust COVID-19 vaccines	137	11.9	(8.4, 15.4)[a]	243	41.1	(33.3, 49.0)	97	22.5	(16.8, 28.1)[a]	297	44.3	(37.0, 51.7)
Don't trust the government	152	14.5	(10.8, 18.1)[a]	204	31.3	(25.3, 37.3)	84	17.2	(11.7, 22.8)[a]	214	35.8	(28.8, 42.8)
Other [b]	181	15.4	(12.1, 18.8)[a]	147	24.3	(18.6, 30.1)	133	25.0	(17.8, 32.2)	173	27.2	(21.4, 32.9)

Note: All percentages and confidence intervals are weighted to the US population.
[a] Response for the category was statistically significant comparing vaccinated parents against unvaccinated parents for children aged 5–11 years and adolescents aged 12–17 years.
[b] Other category includes 1) other people need it more than the children in this household do right now, 2) concern about missing work to have the children vaccinated, 3) unable to get a COVID-19 vaccine for children in this household, 4) parents or guardians in this household do not vaccinate their children, 5) concern about the cost of a COVID-19 vaccine, and 6) other.

vaccinating adolescents were concerns about side-effects (53.0% and 62.1% among vaccinated and unvaccinated parents, respectively). Lack of trust in COVID-19 vaccines (44.3% vs 22.5%), lack of trust in the government (35.8% vs 17.2%), and belief that children do not need the vaccine (34.3% vs 18.3%) were higher among unvaccinated parents compared to vaccinated parents. For adolescents, parental uncertainty of the vaccine's effectiveness was higher among unvaccinated (16.4%) than vaccinated (7.5%) parents.

An ecological analysis also showed that states with high parental vaccination coverage also had higher child and adolescent vaccination coverage than states with lower parent vaccination coverage (adjusted R-squared = 0.45; Fig. 2). For example, in Vermont where parental vaccination was 94.5%, child and adolescent vaccination was 81.6%. On the other hand, in Montana where parental vaccination was lower at 61.8%, child and adolescent vaccination was 45.4%.

Discussion

Although it is commended that the majority of parents have vaccinated or intended to vaccinate their children or adolescents, a small percentage of parents are reluctant toward vaccinations. This is among the first studies to quantify the association between parental vaccination status and child and adolescent vaccination status. As expected, parents who were hesitant about getting vaccinated against COVID-19 themselves were significantly less likely to report that they would vaccinate their children, compared to those who had received a vaccine. Approximately 10% and 4% of vaccinated parents were reluctant toward vaccination for their children and adolescents, respectively. This study shows that vaccinated parents who have not vaccinated their children or adolescents were more likely to report that they would like to wait and see if it is safe. As a result, a targeted messaging campaign to explain the benefits and any potential side-effects, address misinformation, and the misconception that the vaccine is not needed for children is important for ameliorating concerns or reducing other barriers to vaccination.[19]

Approximately one in 10 parents of children reported that lack of a healthcare provider recommendation was a reason for not vaccinating their children. Studies have shown that healthcare provider recommendation is significantly associated with COVID-19 vaccination status and confidence in the safety of vaccines.[20] Empowering healthcare providers to have discussions about, and recommend, COVID-19 vaccines for parents as well as their children are important for protecting families from the serious effects of COVID-19.

Child and adolescent COVID-19 vaccination were higher among those who had preventive check-ups in the past year, underscoring the need to address disparities in vaccination among families who may not have regular access to healthcare services. Studies have found that children's preventive services and routine vaccinations were delayed, missed, or skipped during the pandemic due to medical office closures and parental fears about COVID-19 exposure in doctors' offices.[21–23] The CDC and the American Academy of Pediatrics (AAP) recommend that children see their doctor for well-child visits annually to receive preventive health services and routine vaccines.[24] Catch-up of preventive services and routine vaccines can be improved by reminding parents of the continued need for preventive services during emergencies, providing parents with timely notices when preventive services are due, and promoting tools to conduct reminders and recalls.[25] Although the COVID-19 vaccine is available for free, other routine vaccines can be provided at no cost for eligible children (those who are Medicaid-eligible, uninsured, underinsured, or American Indian/Alaskan Native) through the Vaccines for Children (VFC) program.[26] Making

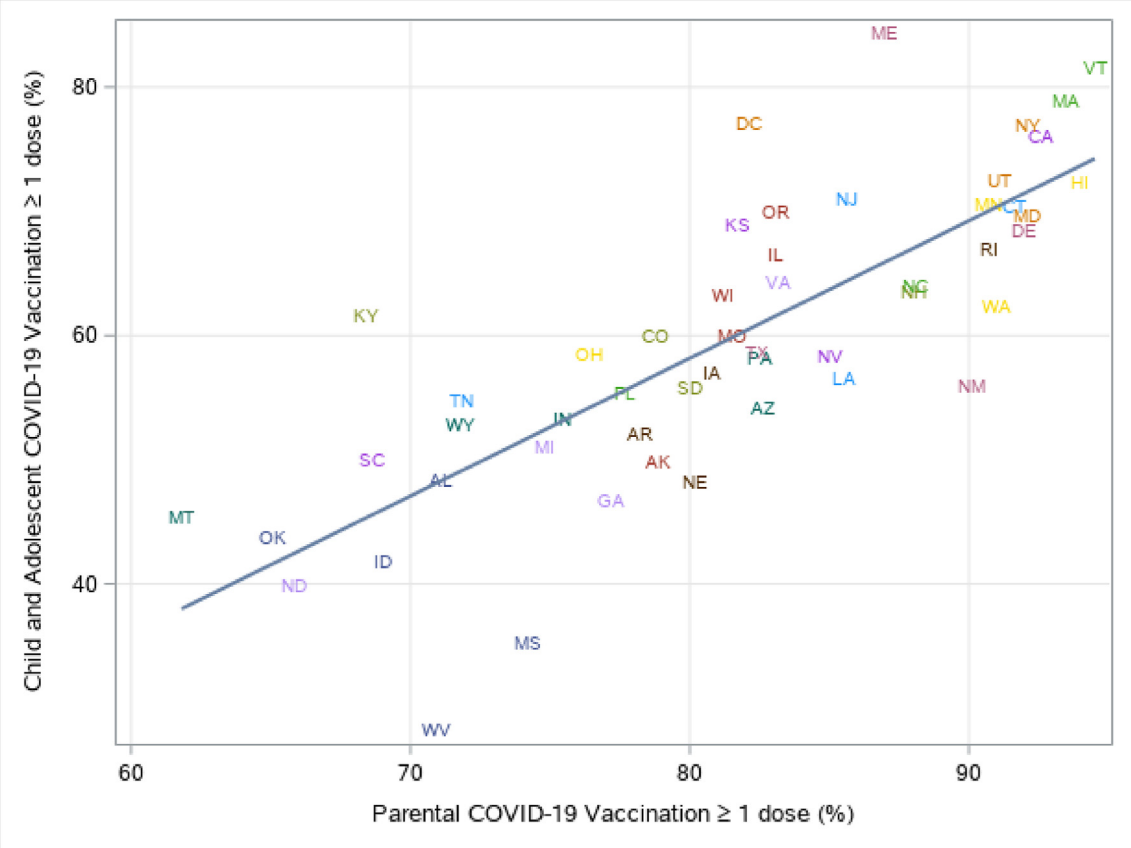

Fig. 2. Prevalence of children and adolescent COVID-19 vaccination and parental COVID-19 vaccination by state, Household Pulse Survey, December 29, 2021–January 10, 2022.

sure that children see their doctor for each well-child visit and recommended vaccines can protect children and prevent serious diseases.

These findings are subject to several limitations. First, although sampling methods and data weighting were designed to produce nationally representative results, respondents might not be fully representative of the general US adult population.[27] Second, vaccination status for respondents and their children was self-reported and is subject to social desirability bias. Furthermore, the analyses were limited to only households with children ages 5–11 years or 12–17 years, and results may be different for households with children in multiple age ranges. For example, parents who have children across all age ranges may be more likely to vaccinate younger children if they had already vaccinated their older children. Finally, the HPS has a low response rate (<10%); although non-response bias assessment conducted by the Census Bureau found that the survey weights mitigated most of this bias.[27]

Conclusions

With the winter 2021–2022 rise in COVID-19 cases due to the highly transmissible Omicron variant,[7] the resumption of in-person education and social activities, and the removal of mask mandates, having high and equitable vaccination coverage is important for preventing infection, transmission, and adverse health consequences. With COVID-19 as one of the top 10 causes of death for children aged 5–11 years; vaccination among this population is critical.[28] Healthcare providers and government leaders can help increase adult and child vaccinations by emphasizing that COVID-19 vaccines are safe, effective, and authorized for all children and adults ages 6 months and older, and emphasizing that serious side-effects are rare. Targeting parents who themselves are not vaccinated, building trust and/or having trusted messengers (i.e., healthcare providers) deliver information may be effective in increasing confidence in vaccines and protecting families and communities.

Author statements

Ethical approval

This study was reviewed by the Tufts University Health Sciences Institutional Review Board and determined as not human subjects research (study ID: 00002308).

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Competing interests

The authors have no conflicts of interest relevant to this article to disclose. None of the authors have financial relationships relevant to this article to disclose.

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Review Paper

Community preferences for the allocation of scarce healthcare resources during the COVID-19 pandemic: a review of the literature

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ABSTRACT

Objective: The purpose of this thematic review is to examine the literature on the publics' preferences of scarce medical resource allocation during COVID-19.
Study design: Literature review.
Methods: A review of Ovid MEDLINE, Embase, CINAHL and Scopus was performed between December 2019 and June 2022 for eligible articles.
Results: Fifteen studies using three methodologies and spanning five continents were included. Five key themes were identified: (1) prioritise the youngest; (2) save the most lives; (3) egalitarian allocation approaches; (4) prioritise healthcare workers; and (5) bias against particular groups. The public gave high priority to allocation that saved the most lives, particularly to patients who are younger and healthcare workers. Themes present but not supported as broadly were giving priority to individuals with disabilities, high frailty or those with behaviours that may have contributed to their ill-health (e.g. smokers). Allocation involving egalitarian approaches received the least support among community members.
Conclusion: The general public prefer rationing scarce medical resources in the COVID-19 pandemic based on saving the most lives and giving priority to the youngest and frontline healthcare workers rather than giving preference to patients with disabilities, frailty or perceived behaviours that may have contributed to their own ill-health. There is also little public support for allocation based on egalitarian strategies.

Background

Since the outbreak of the coronavirus (COVID-19) pandemic, there have been over 496 million confirmed cases and 6.17 million deaths.[1] The rapid evolution of the virus saw a dramatic increase in patients, particularly the elderly and those with severe illness, which began to overwhelm the health systems in many countries, resulting in shortages of medical resources, such as ventilators and intensive care unit (ICU) beds and now vaccines.[2] The surplus in demand exceeding the availability of healthcare resources led to the unavoidable rationing of medical equipment and interventions, most notably critical care resources which are challenging to expand in a short time.[3–6] How health services and clinicians respond to the need for rationing of scarce but vitally important resources could potentially be a life-and-death situation for patients.

Previous authors have highlighted that hospitals lack a standardized foundation on which to make these rationing decisions.[7–9] In response, ethicists and healthcare policymakers developed guidelines and protocols to avoid health systems becoming overwhelmed[10] as well as to help physicians make challenging decisions.[3,5,10,11] These decision-making frameworks can have a direct impact on the access to services and health of the public. This process is not dissimilar to what has occurred in other fields where there are scarce health resources. Arguably the most prominent example is that of allocating donated organs, where previous work has synthesised the views of ethicists,[3,12–14] clinicians[15,16] and the public[17–20] as to how this allocation process should take place. However, none of the current COVID-19 guidelines involved community consultation;[21–27] therefore, it is

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unknown to what extent the current COVID-19 allocation policies align with community preferences and values.

Allocation of scarce health care during pandemic conditions that can be guided by rules and recommendations that do not align with the public's opinions and values could create feelings of injustice and distrust of governments and health systems. This was shown in the UK where early in the pandemic, the UK's National Institute for Health and Care Excellence (NICE) drafted allocation guidelines proposing that all adults on admission to hospital, irrespective of COVID-19 status, be assessed for frailty and that comorbidities and underlying health conditions should be considered.[27] This was eventually revised after concerns were raised by several patient groups that the policy would disadvantage some groups, such as those with disabilities.[28] This example highlights the difficulty of balancing different ethical criteria, a difficulty exacerbated by the need to make urgent clinical decisions.[3] It further highlights the importance of engaging the public in priority setting in health care, a principle that has been widely advocated for.[29]

As COVID-19 will not be the last pandemic to occur and challenge healthcare systems and in addition to preparing for future healthcare resource shortages, efficient allocation of resources need to be better planned. Therefore, it is necessary to involve the public in discussions before another healthcare crisis eventuates so that resource limitations would not lead to arbitrary allocation decisions, which can lead to public confidence in both health professionals and health systems.[30–33] To help inform such discussions, we conducted a synthesis of the literature that has examined the public's perceptions regarding scarce medical allocation during the COVID-19 pandemic.

Methods

Search strategy

A systematic search was carried out using Ovid MEDLINE, Embase, CINAHL and Scopus using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 Statement.[34] Specific search strategies were developed with expert librarian support using the search terms: 'COVID-19', 'coronavirus', 'community', 'layperson*', 'general public', 'decision making', 'preferences', 'healthcare resource allocation', 'rationing' and 'medical ethics'. Additional data were located with the use of Google Scholar and a search of the reference lists of included articles.

Eligibility criteria

Included were articles that met the following inclusion criteria:

1. Studies published in a peer-reviewed source since December 2019 to coincide with the COVID-19 pandemic outbreak. Abstracts, comments, posters and editorials were excluded.
2. Studies that assessed community preferences for allocation of scarce healthcare resources during the COVID-19 pandemic outbreak. Note: Healthcare resources are defined as any material (e.g. ventilator, ICU bed, vaccine) and facility (e.g. hospital) that can be used for providing healthcare services.

Article selection

The initial database searches were conducted by two researchers and the retrieved literature was imported into Endnote 9.1. Two researchers also independently screened the titles and abstracts of the search results and cross-checked. After initial screening, full texts were downloaded and two researchers read full texts. Disagreements between the researchers were resolved through discussions with a third researcher until consensus was reached.

Data charting process

Relevant data were extracted by two researchers using Excel (Microsoft Corporation), including the first author, country of origin, study design, sample size and key findings for each selected article.

Collation of results

The variation in study designs across articles meant that conducting a systematic review was not possible. Therefore, a thematic synthesis of the findings was conducted using inductive coding to identify emerging themes. As there are no formal guidelines for literature reviews with thematic synthesis, two researchers organised the review into paragraphs that present the themes and identified trends relevant to our topic. Following this, descriptive themes were developed to group common preferences and named accordingly.

Search results

Overall, 636 records were identified (Fig. 1). After the removal of 33 duplicates, 603 abstracts were reviewed against the inclusion criteria. The full texts of 57 articles were reviewed and 44 were excluded. The addition of two articles, identified in a later search, resulted in 15 eligible articles being included.

Results

Study characteristics

Table 1 shows that included studies were conducted in the USA,[5] Australia and Germany (2 apiece), Iran, Belgium, Israel, the UK and Portugal (1 apiece), while one study was conducted across 11 nations. Studies focused on the allocation of: ventilators,[35–42] ICU beds[43–45] and COVID-19 vaccines.[35,46,47] Various combinations of ethical allocation principles were examined using hypothetical scenarios with ranking,[38,41,46] rating tasks[36,48] or person trade-off methods.[35,37,39,40,42,43,45,47–51] Participant sample size ranged from 306 to 5175. Data were collected between April and December 2021 using cross-sectional online surveys (all) and telephone interviews.[46]

Themes

Five themes emerged from the data that represented the public's preferences for scarce resource allocation under COVID-19 conditions. These are discussed in more detail below.

Theme 1: Prioritise the youngest

Thirteen studies examined the public's preference for favouring younger patients under pandemic conditions.[35–43,45,46,50,51] This theme aligns with the 'prioritisation' principle, where the goal is to give preference to younger individuals over older individuals because they have had the least opportunity to live through life's stages.[52]

Patient age appeared to be a major criterion across studies as when patient age and prognosis were examined together, most respondents gave priority to the youngest patients irrespective of prognosis. Several studies reported that most study participants elected to allocate treatment to a younger patient rather than an older patient in situations where life expectancy and survival chance were said to be the same.[38,42,46,48] For example, one study

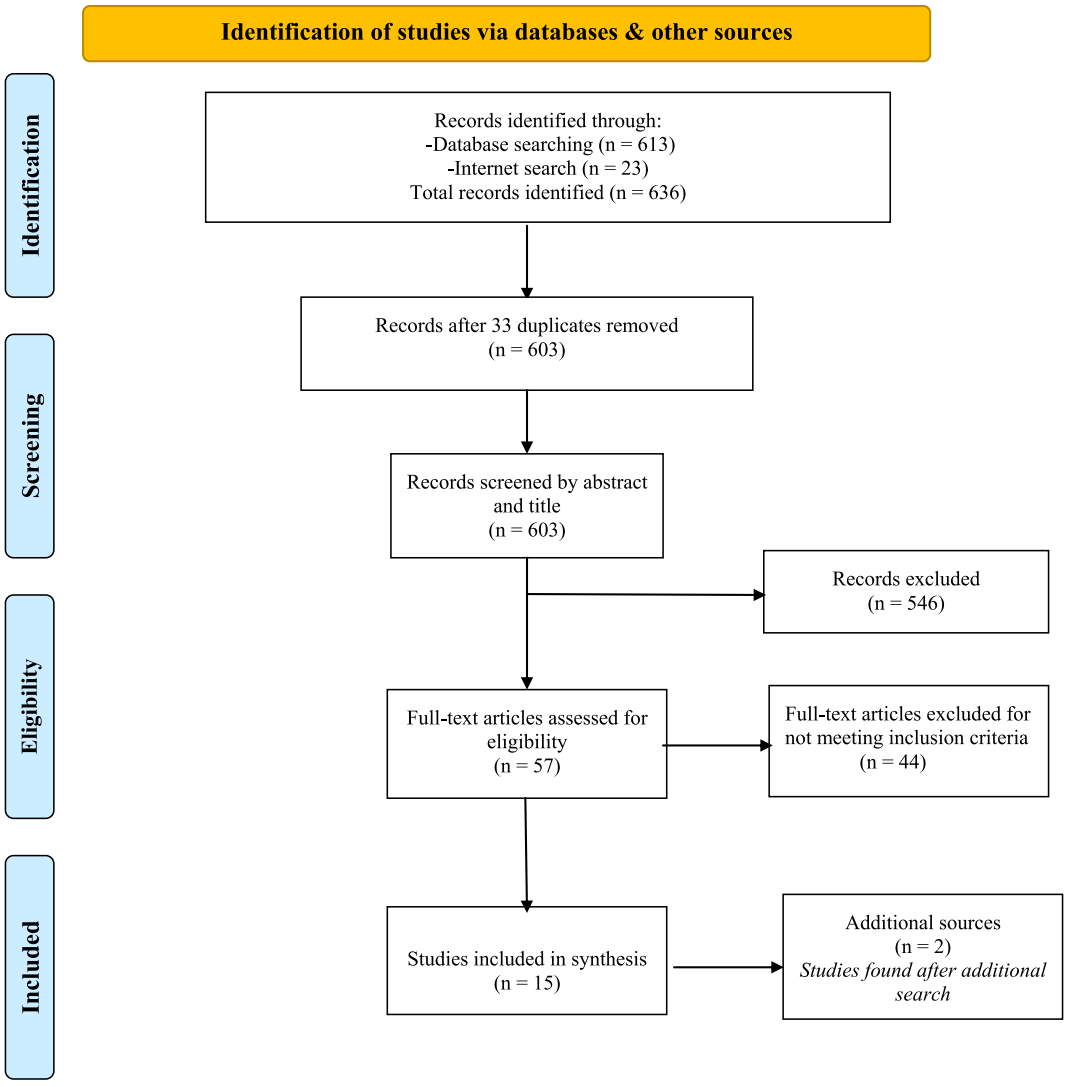

Fig. 1. Search process flowchart (PRISMA flow diagram).[38]

reported that when participants were asked to allocate ventilators to patients with similar prognoses, priority was given to younger patients over older patients.[38] Another study identified that the public were more in favour of treating a 10-year-old child with little chance of recovery over a 70-year-old with a high survival probability (30% vs 41%, respectively).[35]

Theme 2: Save the most lives

Another prominent theme was for saving the most lives during COVID-19 and can be regarded as an application of utilitarianism, which seeks to maximise total population health by saving the most lives or as many years of life as possible.[53] This was assessed across 10 studies in terms of a patient's survival probability.[35,36,39,40,42,43,45,48,50,51]

In most studies, the majority of participants allocated high priority for triage policies that prioritised allocation for patients with higher survival chances.[36,39,40,42,43,45,46,48,50,51] For example, Wilkinson and colleagues found that approximately 92% of participants chose to treat a patient with an 80% survival chance, whereas only 5% gave priority to a patient with a 10% probability of survival.[42] Several studies found that participants appeared willing to withdraw treatment from a patient in ICU who had a lower survival chance than another patient with a higher survival probability currently presenting with COVID-19.[42,43]

Theme 3: Egalitarian allocation approaches (e.g. waiting lists and random allocation)

This theme relates to giving all patients an equal chance at receiving scarce resources through applying a first-come, first-served basis or random allocation strategy,[54] and encompasses the principles of egalitarianism, which aims to give all patients an equal chance at receiving scarce resources.[54] Nine studies assessed public support for these allocation strategies.[35–37,39,40,42,43,45,46,48,50,51]

Evident across studies that while the public are least supportive of allocation based on order or randomisation, there was heterogeneity in people's moral judgements toward them and this appeared to be influenced by whether or not specific characteristics of competing patients were presented to participants. For example, when asked to consider triage policy statements that contain no information about the patients' age or prognosis, most participants outrightly rejected both randomisation and first-come, first-served principles[35–37,39,40,42,43,46,48,50,51] or were ambivalent.[40] Conversely, when presented with patient clinical information, and age, participants were more likely to default to an 'equal chance'

Table 1
Characteristics of included studies.

Author/Year	Study description	Country of origin	Participants (*n*)	Key findings
Ventilator allocation				
Asghari (2021)[40]	Online survey; 11 allocation statements; respondents agreed/ disagreed with statements.	Iran	1262	Priority based on survival probability, quality of life & social usefulness. Little agreement with prioritization based on first come, first served.
Huang (2020)[41]	Online survey. Two-stage experimental design (respondents assigned to conditions with/without veil of ignorance applied).	USA	1276	Veil of ignorance (VOI) reasoning[b] favours allocating scarce ventilators to younger patients over older patients, showing that when engaged in VOI reasoning, respondents are more likely to approve of allocation that aims to saving the most lives.
Huseynov (2020)[42]	Online survey; 1 hypothetical scenario: allocation of 100 ventilators among 1000 COVID-19 patients of varying ages.	USA	586	Priority based on survival probability (younger patients). Preference for treating own age group equally.
Jin (2021)[43]	Online choice based conjoint design; 15 choice sets; 2 hypothetical patients. Recruitment across 11 countries (USA, Brazil, India, UK, Italy, Germany, France, Australia, Spain, China and South Korea)	USA	5175	Priority based on survival probability (i.e. allocation to younger patients).
Norman (2021)[44]	Online DCE[a]; 12 choice sets.	Australia	1050	Priority based on survival probability (i.e. younger, non-smokers), social usefulness & without disability.
Werner & Landau (2020)[45]	Online survey; 3 hypothetical patients with/without Alzheimer's Disease. Respondents allocated ventilator by order (1st, 2nd and last).	Israel	309	Priority based on survival probability & quality of life. Least priority is given to oldest patient with cognitive disorder.
Wilkinson (2020)[46]	Online survey; 38 choices: 2 hypothetical patients.	UK	768	Priority based on survival probability, quality of life & social usefulness. Support for reallocating treatment to save more lives
Intensive care bed (ICU) allocation				
Fallucchi (2020)[47]	Online survey; 8 hypothetical triage statements: 2 patients.	USA	1033	Priority based on survival probability, social usefulness & those infected with COVID-19. Support for reallocation only when patient has received treatment for 2 months.
Street (2021)[48]	Online DCE[a]; 7 choice sets; 14 patient pairs. Respondents prioritise care between two patients requiring ICU bed.	Portugal	306	Priority given to patients based on their prognosis (e.g. younger) and social usefulness (i.e. healthcare workers, caregivers).
Ventilator and intensive care bed (ICU) allocation				
Pinho (2021)[39]	Online survey; 6 hypothetical allocation statements; 2 patients of different ages, professions, symptom severity, survival.	Australia	306	Priority given to patients based on their prognosis, followed by severity of health condition and age. When confronted with survival, youngest first was preferred. Egalitarian allocation least preferred.
Sprengholz (2022)[49]	Online survey to investigate public's prioritisation preference toward ICU admission for patients who differed in health condition, expected treatment benefits and COVID-19 vaccination status.	Germany	1014	Priority given to treating (1) patients who are vaccinated over non-vaccinated; (2) patients with serious health conditions (e.g. heart attack) over patients with COVID-19. The public also more likely to admit a patient to ICU when this meant withholding rather than withdrawing care from another patient.
Generic triage policy allocation				
Buckwalter & Peterson (2020)[50]	Three online experiments to investigate public attitude toward hypothetical triage allocation statements.	USA	1868	Priority based on survival probability & seriousness of condition, but not when entail reallocation between existing patients, or when they disadvantage at risk groups.
COVID-19 vaccine allocation				
Gollust (2019)[49]	Online & telephone survey to assign preference (high-med-low) for delivery of COVID-19 vaccination; 8 hypothetical population groups.	USA	586	Priority to people with lower age, higher risk of dying from COVID-19; are pregnant, medical workers or non-medical essential workers.
Luyten (2020)[51]	Online survey to assign preference (most appropriate-least appropriate) for delivery of COVID-19 vaccination (8 hypothetical population groups).	Belgium	2060	Priority to people who are: essential workers, chronically ill and older. Least preferred were egalitarian strategies (e.g. lottery, first come, first served).

Table 1 (*continued*)

Author/Year	Study description	Country of origin	Participants (*n*)	Key findings
Sprengholz (2021)[51]	Online survey to examine public opinion toward: (1) government COVID-19 allocation policy objectives; and (2) allocating vaccine priority to certain groups (e.g. older vs younger, workers with high exposure risk, nursing home residents).	Germany	1379	Public support official COVID-19 vaccination policy objectives. Public support giving vaccine priority to workers with high exposure risk. Least support for assigning priority to older individuals and those living in nursing homes.

[a] DCE = discrete choice experiment.
[b] Veil of ignorance reasoning = is designed to elicit impartial decision making by denying respondents potentially biasing information about who will benefit the most or least from the available options.

position.[35–37,39,40,42,43,46,48,50,51] For example, one study found that over half of participants (55%) chose a coin toss to decide between two patients with small differences in life expectancy (15 vs 14 years).[42]

Theme 4: Prioritise healthcare workers

Eight studies[35–37,39,40,42,43,46,48,50,51] examined public attitude toward prioritization of healthcare workers patients. This appeared to be a popular strategy among participants in seven studies.[35–37,39,40,42,43,46–48,50,51] For example, one study examining COVID-19 vaccine priority found that almost all participants (92%) preferred to give vaccines to frontline healthcare workers before others, including individuals who were at high risk of mortality from COVID-19.[46] Another study reported that 63% of the study sample prioritised healthcare workers to receive the remaining ventilator over a non-healthcare professional.[42]

Theme 5: Bias against particular groups

Nine studies examined the public opinion toward allocation bias.[36,39–42,45,48,50,55] That is, differences in how participants' preferences for assigning treatment to specific patient groups, such as those with disabilities and frailty and those with perceived behaviours that may have contributed to their ill-health.

The general public did not appear to favour allocating limited healthcare resources, such as ventilators or ICU beds to patients who were smokers,[40] had poor self-rated health,[50] had criminal histories,[39] or were illicit drug users.[48] Patients who were considered likely COVID-19 spreaders or did not comply with COVID-19 rules, such as mask wearing or social distancing were also not given treatment priority by the community.[55] The public were also less willing to give lower priority to patients with disabilities[40,42,48] or those with high degrees of frailty.[42] For example, one study reported that the majority of respondents (74%) elected to allocate treatment to a non-disabled patient in preference to a patient with a profound learning disability,[42] whereas only a minority (~19%) elected to treat patients with greater disability.[42] Another study reported that the public gave priority for COVID-19 vaccinations to staff in medical facilities, outpatient care and nursing homes for the elderly over vulnerable groups (e.g. nursing home residents and people aged 75 years and older).[47]

Discussion

This study identified several themes related to how the general public preferences the allocation of health care resources during the current COVID-19 pandemic. Our findings show that the public have a clear preference for allocation that aims to save the most lives and give priority to younger patients and health care workers. Participants also demonstrated some degree of allocation bias, deprioritising of those with disabilities and directing resources away from people with behaviours that increased their own risk of becoming diseased. Less support was also found for egalitarian allocation approaches such as first-come, first-served or randomization approaches, particularly when additional information about patient scenarios (e.g. prognosis) were added into scenarios.

These findings can be contrasted with previous research and published opinions that have examined how to allocate resources in the context of resource scarcity (see Appendix 1). Donor organ allocation is one area that faces ongoing scarcity and ethical debate and therefore makes a useful and relevant comparison to our study.[17,56] It is evident that, irrespective of context, the public view reducing mortality as an important achievement when considering scarce healthcare allocation. When selecting organ transplant recipients, the public regard the capacity to survive and benefit as one of the most important criteria,[17,56] which aligns with our finding of prioritised allocation for patients with higher survival chances under COVID-19 conditions. This is also consistent with prior research examining community preferences under pandemic conditions.[57–62] It is also apparent that across contexts the public make judgements based on a patient's lifestyle decisions under conditions of scarcity in that the public are willing to assign less priority to individuals with perceived behaviours that may have contributed to their illness for both donor organ recipients[17,56] and COVID-19 patients.[36,39–42,45,50,55] Prior studies also suggest that the public tend to negatively sanction those who are deemed responsible for their predicament.[63–67] These overall findings suggest that while the community are willing to endorse allocation policies that maximise the number of lives saved during conditions of healthcare scarcity, they also believe the patient's *deservingness* to receive scarce treatment should be taken into consideration. Our findings may have particular importance in the current COVID-19 context as individuals with substance abuse disorders, for example, are a high-risk group for contracting COVID-19 and its transmission and casualties because they usually suffer from poorer health, weaker immune function, chronic infections, as well as various issues with physical and psychiatric comorbidities.[68,69]

Some of our findings appear less consistent with the preferences expressed among community members for the allocation of donor organs[17,56] (see also Appendix 1). When considering donor organ allocation, the public are not in favour of prioritising patients based on their occupation,[17,56] whereas we found strong community support for giving preferences to healthcare workers during COVID-19. Rather, community opinion is that patients in need of a donor organ should be placed on a wait list *unless* they are children, patients with dependents or have spent long periods on a wait list.[17,56] Under COVID-19 conditions, we observed little community support for treating patients on a first-come, first-served basis. When comparing our findings with prior studies of allocation during pandemics, we also find mixed support for these principles.[59,70] Studies examining public attitudes toward limited

healthcare distribution during an influenza pandemic, for example, have reported inconsistent results.[59,61] For example, one study found community support for prioritising healthcare workers for treatments,[62] whereas another study reported public support for wait lists but not instrumental value.[61] However, it should be noted that these studies were not conducted under 'real-life' global pandemic conditions, so it is plausible that our findings may be more of an accurate reflection of community sentiment during a public health crisis.

Expert opinions related to this field have also been published. For example, in 2020, the New England Journal of Medicine published an opinion paper written by medical ethicists discussing recommendations for the allocation of scarce medical resources during the COVID-19 pandemic.[71] Overall, there was high agreement between our findings and the opinions of these authors for allocation strategies under COVID-19 conditions (see Appendix 1). For example, the overarching view among both groups is that one of the most important goals of pandemic preparations is mortality reduction or 'saving the most lives', especially to individuals who may be at 'risk of dying young and not having a full life'.[71] In addition, members of the community and ethicists agree that treatment preference should be given to frontline COVID-19 healthcare workers because of their instrumental value in keeping critical infrastructure operating.[71] However, the public disagree with these authors' recommendation that treatment priority should be given to people involved in COVID-19 therapeutics research and development (e.g. vaccines).[71] Further agreement was also reached on allocation strategies where patients had small differences in treatment outcomes. That is, when presented with patients with small differences in survival probability, the public appears to agree with the authors' position that randomization should be applied rather than wait lists.[71]

Conclusion

Under COVID-19 conditions, the public appear to agree that saving the most lives, especially the youngest, is the most important principle for scarce resource allocation. In addition, the public support giving treatment priority to frontline healthcare workers and are willing to deprioritise particular patient groups, such as those with disabilities or those who are considered to having contributed to their own ill health in some way (e.g. drug takers, smokers). Allocation involving egalitarian approaches received the least support among community members. The values expressed by the public under pandemic conditions were found to both converge and diverge from expert guidance as well as with community attitudes toward donor organ allocation. Awareness of these differences highlights the importance of involving the public in discussions around the efficient allocation of scarce resources and here qualitative research would be helpful in understanding an individual's motivation for their allocation preferences.

Author statements

Ethical approval

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Competing interests

All authors declare that they have no financial, personal, or potential conflict of interest.

Appendix A. Supplementary data

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Original Research

Coping strategies during legally enforced quarantine and their association to psychological distress level: a cross-sectional study

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ABSTRACT

Objectives: The non-pharmacological measures to contain the COVID-19 pandemic may lead to considerable psychological distress. The aim of the CoCo-Fakt study was to investigate possible coping strategies and their effects on psychological distress during legally enforced quarantine of infected persons (IPs) and their close contacts (CPs).
Study design: This was a cross-sectional cohort study.
Methods: From 12 December 2020 to 6 January 2021, all IPs and their CPs (n = 8232) registered by the public health department (Cologne, Germany) were surveyed online. Psychosocial distress and coping were measured using sum scores; free-text answers related to specific strategies were subsequently categorised.
Results: Psychosocial distress was higher in IPs than in CPs ($P < .001$). Although the mean coping score did not differ between both groups, it was influenced by the reason for quarantine (IP vs CP) besides gender, age, socio-economic status, living situation, psychological distress, resilience, physical activity and eating behaviour. This final regression model explained 25.9% of the variance. Most participants used active coping strategies, such as contact with the social environment, a positive attitude and hobbies.
Conclusions: Although psychological distress was higher in IPs than in CPs during the quarantine period, the mean coping score did not differ. The strategies most frequently used by IPs and CPs were activating social networks, a healthy lifestyle and professional support systems, such as the health department helpline. Appropriate advice should be implemented to prevent long-term psychological consequences when supporting affected people.

Introduction

The COVID-19 pandemic, which first appeared in Wuhan, China, in December 2019, spread rapidly globally.[1,2] In the absence of possible therapeutic countermeasures and the vaccinations that only became available in Germany at the end of 2020, various contact restrictions and curfews were imposed to protect high-risk groups and to prevent an overload of the health system. Because of these restrictions, the pandemic has had an enormous impact on the daily lives and mental health of the general population. Several studies described an increase in loneliness, symptoms of anxiety and depression.[3–6] The 'new' term 'social distancing' with its negative connotation could intensify this burden through the feeling of being left alone, ignored and excluded or induce a feeling of being a burden for society and one's private surroundings.[7]

Previous studies implicate that quarantined people due to a SARS-CoV-2 infection or as close contacts might have particularly serious mental health consequences.[8] Benke et al. examined the effects of different forms and levels of restriction resulting from

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public health measures (e.g. quarantine and stay-at-home order) on anxiety and depression symptomatology, health anxiety, loneliness, the occurrence of fearful spells, psychosocial distress and life satisfaction.[9] Higher restrictions due to lockdown measures, a greater reduction of social contacts and greater perceived changes in life were associated with higher mental health impairments. Noteworthy, an officially announced stay-at-home order was not associated with poorer mental health; but in their study, only 28.4% (n = 1187) were mandatory quarantined.[9] Other studies by Kołodziejczyk et al. and by the TMGH-Global COVID-19 Collaborative, in turn, were able to show significantly poorer mental health in people who were quarantined as an infected person (IP) or a close contact (CP).[10,11] Psychopathological symptoms such as anxiety, insomnia and hyperarousal were much more frequent in this group.[10] The extent to which psychological well-being, and thus long-term psychological outcome, is affected by a stressor may depend on the use of positive or negative coping strategies.[12] However, even the designation or conceptualisation of coping is challenging.[13] The most commonly used definition by Lazarus and Folkmann describes coping as a cognitive or behavioural reaction to manage a situation.[14] Mostly coping is categorised in two main dimensions: problem-oriented coping and emotion-oriented coping.[15] The starting points are the relationship to the surroundings and the interpretation of these, respectively. This can be supplemented by the perspective of distraction, which can be social as well as task oriented.[16] Skinner et al., on the other hand, call for a revision of the previous classification towards a multidimensional and hierarchical system.[13] However, given the complexity and lack of comparability to other studies, this model is not applied in our study.

Park et al. analysed the use and impact of different coping mechanisms during the onset of the COVID-19 pandemic in April 2020 in the United States. The most frequently cited strategies were distracting oneself, seeking emotional-social support and active problem-focused coping.[17] Saalwirth et al. also examined the effects of coping strategies in spring 2020 in Germany via online questionnaire. The results show that meaning- and problem-focused coping were used most frequently. These types of coping were positively associated with positive affect. In contrast, social and avoidance coping showed a positive relationship to negative affect.[18] Budimir et al. identified positive thinking as the strongest positive predictor for all measured mental health scales, including quality of life or depression.[19] In a study by Golemis et al. from Greece, sharing thoughts and feelings with others about COVID-19 was reported as the most frequently used mechanism.[20] Along with sports and humour, this predicted lower levels of loneliness.[20] However, in these studies on coping, the term quarantine was used to refer to general isolation measures of the general population. So far, however, no studies have analysed the use of coping strategies in the context of a mandatory stay-at-home order and the relationship with psychosocial distress considering IPs and CPs in Germany. Therefore, the aim of the CoCo-Fakt study (Cologne–Corona Counselling and Support For Index and KontAKt Persons During the Quarantine Period) was to examine (1) the overall coping score and (2) type and frequency of coping strategies of officially quarantined IPs and CPs. (3) Additional factors influencing coping such as sociodemographic variables, psychological distress and/or resilience were also identified to develop recommendations for action during the quarantine period counteracting possible long-term psychological consequences.

Methods

Study design/study population

Since the occurrence of the first COVID-19 infection in Cologne at the end of February 2020, all people who tested positive for SARS-CoV-2 (IPs) in the urban area of Cologne were reported to the Cologne Health Department and quarantined based on the legal regulations for the control of infectious diseases defined by the Infection Protection Act. For this purpose, these people are contacted, registered in the database of the Cologne public health department's digital contact management (DiKoMa) system[21] and questioned in a standardised manner about possible infection routes, chronic diseases and risk factors. In addition, close contacts (CPs) are also quarantined to interrupt infection chains. CPs are defined as those who have had close exposure to a confirmed COVID-19 case (<1.5 m) for a duration longer than 10 min without a mask within a time frame ranging from 2 days before symptom onset in the index case to 10 days after symptom onset. The quarantine duration was usually 10–14 days from the time of symptom onset or positive test in IPs and from the last contact in CPs.

All individuals enrolled before and on 9 December 2020 were extracted from this data set; individuals aged <16 years, those with no informed consent, non-compliance, deceased patients and those who were placed in medical or nursing facilities were excluded. Pregnant women received a modified online questionnaire.[22] From 12 December 2020 to 6 January 2021, the link to the online survey was emailed to 33,699 people. This link was clicked on by 13,057 people. After cleaning the data, only people who provided information on coping strategies were integrated into this evaluation (n = 8232; see Fig. 1: Study population).

Questionnaire

The online questionnaire was programmed with Unipark. It included both quantitative and qualitative parameters and was based on the COVID-19 snapshot study conducted by Betsch et al. and the World Health Organisation.[23] Participants were explicitly informed of the period to which each question referred, for example, general data, such as education, exercise behaviour before the pandemic, psychological disstress or coping strategies during the legally mandated quarantine.

Demographic data

Information was collected on age (years) and gender (male/female). Educational status was calculated according to years of schooling completed (<10 years corresponds to low socioeconomic status [SES], 10 years to medium SES and >10 years to high SES).[24,25] Conclusions about migration background were based on the primary language spoken at home (No = speak German at home and Yes = speak a language other than German).

Personal situation

Information was collected regarding the presence of chronic diseases,[25] the housing situation (house/flat with garden and/or balcony vs no balcony/no garden), the composition of the household (partner and children) and the symptom burden (only for infected people). The quarantine duration was measured in days.

Psychological distress

Five items from the COVID-19 Snapshot Monitoring study (COSMO) were integrated:[26]

- 'I felt nervous, anxious or tense'[27] (Item 1, Generalised Anxiety Disorder Scale-7 [GAD-7])
- 'I felt down/depressed'[28,29] (Item 6, Generalised Depression Scale [ADS])
- 'I felt lonely'[28,29] (Item 14, ADS)
- 'I thought of the future with hope'[28,29] (Item 8, ADS)

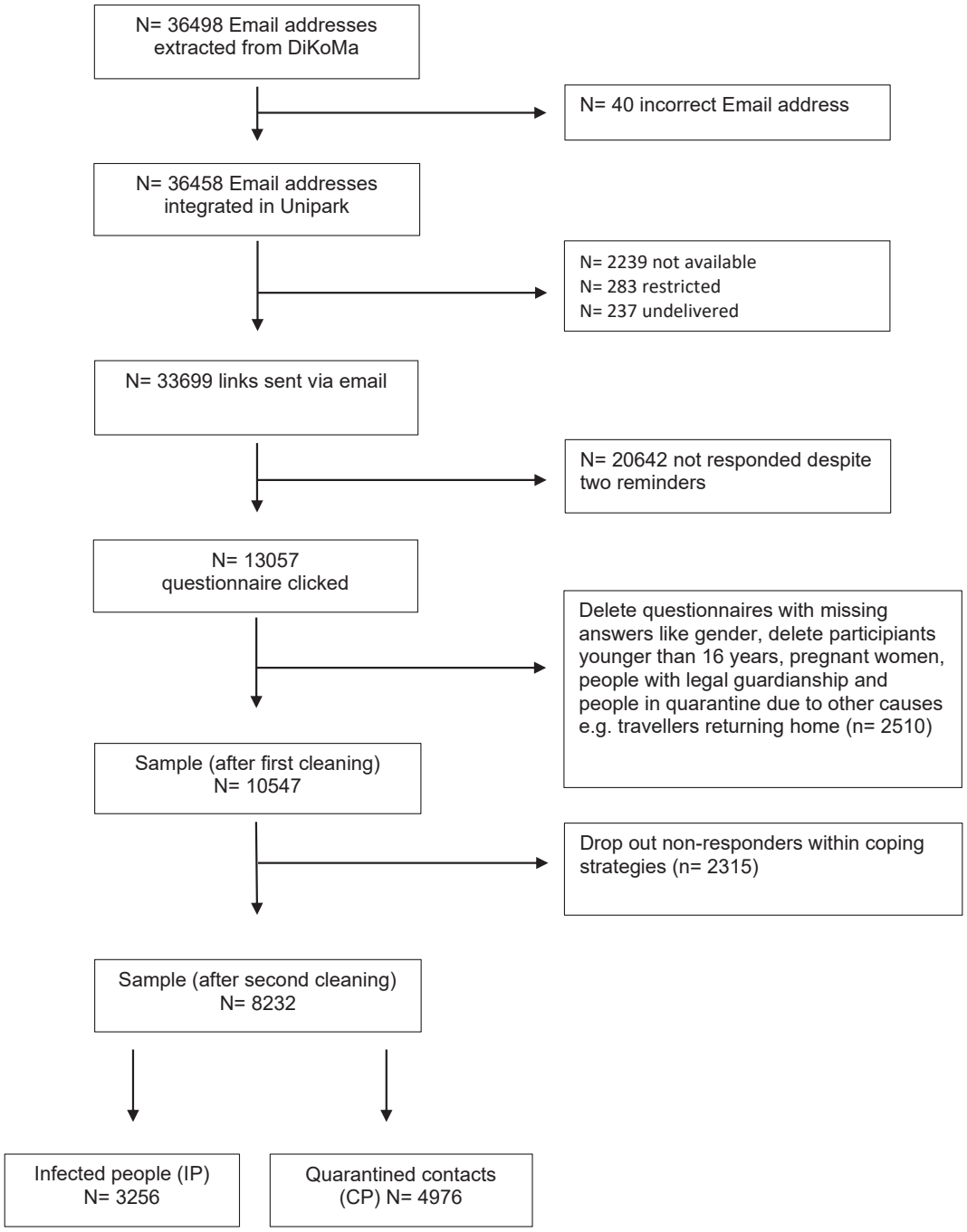

Fig. 1. *Study population.*

- 'Thoughts of my experience in the Corona pandemic triggered physical reactions in me, such as sweating, shortness of breath, dizziness or palpitations'[30] (Item 19, IES-R).

Responses were given on a 6-point Likert scale from 'not at all/less than 1 day' to 'always/daily' and regrouped into 'not at all', '1–2 days', '3–4 days' and '5–7 days' during time of quarantine. Some items were recoded in reverse terms so that all items could then be combined into a total relative sum score related to the number of questions to estimate the overall reported psychological distress in accordance with the COSMO study. A high score represents a high level of psychological distress. The present study found a Cronbach's alpha coefficient of 0.694 for the psychological distress score and reliabilities of the individual questions ranging from 0.532 to 0.781. A value higher than 0.70 would be ideal, a value of internal consistency close to 0.60 is satisfactory in terms of a screening tool with five questions.[31] The complete instructions of the GAD, ADS and IES-R can be found in the respective manuals.[27,28,30]

Resilience

Resilience was measured via six items with the Brief Resilience Scale (BRS; e.g. 'I do not need much time to recover from a stressful event'), ranging from 'I strongly disagree' (1) to 'I strongly agree' (6).[32,33] In addition, some items that asked about the current quarantine situation were used (e.g. 'I know I will not be discouraged').[34] After recoding, a relative sum score after Smith et al. related to the number of questions was formed in accordance with the COSMO study,[32] with a high score representing high resilience.

The present study found a Cronbach's alpha coefficient of 0.812 for the BRS.

Coping strategies

The application of coping strategies and the use of support systems were investigated with the help of six items, following the COSMO study:

- 'I have received offers of support from family, friends or neighbours.'[26] (Item 2, Federal Centre for Health Education [BZgA] – coping)
- 'I had a plan for my daily life in terms of sleep, work or physical activities.'[26] (Item 4, BzgA – coping)
- 'I discovered activities for myself that made staying at home easier.'[26] (Item 6, BzgA – coping)
- 'I have used digital media to communicate with family, friends and acquaintances.'[26] (Item 1, BzgA – coping, modified)
- 'I was bored.'[26] (Item 7, BzgA – coping)
- 'I couldn't do anything myself to influence the situation positively.'[26] (Item 2, solidarity)

Here, too, a 6-point Likert scale was used to collect responses, and a sum score was formed after recoding. A high score equates to increased use of coping strategies. The present study found a Cronbach's alpha coefficient of 0.685 for the coping score and the individual questions ranging from 0.599 to 0.684. Again a value higher than 0.70 would be ideal, a value of internal consistency close to 0.60 is satisfactory in terms of a screening tool with five questions.[31] To compare the answers to the individual questions between the two groups, statements 1–3 on the scale were rated as "not applicable" and statements 4–6 as "applicable".

Answers to the open question 'What helped you most?' were administered and analysed with MAXQDA 2020 (VERBI software) following a deductive approach.[35,36] After an initial coding scheme derived from the given topics of the questionnaire, it was applied to the transcripts by two coders, and emerging themes were identified based on an inductive approach. Discrepancies in coding were resolved by consensus.[37] Finally, 23 relevant categories were identified through selective coding compared with the literature and the COSMO study[38] (see Supplemental material 1). Due to the multiplicity of these answers, the evaluation was exclusively descriptive (Table 4).

Exercise and eating behaviour

A yes/no question about exercise/physical activity during quarantine was included. Eating behaviour was assessed via a Healthy Eating Index. This index was calculated by summing the positive and negative responses from the following three categories: change in mealtime (four items), change in frequency (four items) and change in food (14 items). The score for change in meal time could take a value between 1 and 3; the score for change in frequency, a value between 1 and 5; and the score for change in food, a value between 1 and 2. These individual scores were then summed, a total percentage score was calculated based on the points to be achieved, and terciles were formed (>0.75 corresponded to eating healthier; 0.65–0.75 to no change; and <0.65, to eating less healthily).

Table 1
Demographic data.

Variables	Total	IP	CP	*P* value IP vs CP	Effect size
N	8232 (100.0)	3256 (39.6)	4976 (60.4)		
Sex, n (%)				<.001[a]	.067[b]
Female	5062 (61.5)	1871 (57.5)	3191 (64.1)		
Male	3170 (38.5)	1385 (42.5)	1785 (35.9)		
Age (years)				<.001[c]	.103[d]
Mean (SD[e])	41.6 (14.2)	42.6 (14.3)	40.9 (14.1)		
Range	16–93	16–87	16–93		
Quarantine interval in days				<.001[c]	.122[d]
Mean (SD[e])	11.8 (4.6)	12.1 (5.0)	11.6 (4.3)		
Range	1–42	1–42	1–42		
Migration background, n (%)				<.001[a]	.056[b]
Yes	404 (4.9)	207 (6.5)	197 (4.0)		
No	7695 (93.5)	2977 (93.5)	4718 (96.0)		
Education level, n (%)				.033[f]	.029[b]
Low	68 (0.8)	34 (1.1)	34 (0.7)		
Middle	1510 (18.3)	628 (19.4)	882 (17.8)		
High	6600 (80.2)	2569 (79.5)	4031 (81.5)		
Household structure					
Partner, n (%)				.063[a] n.s.	
Yes	5744 (69.8)	2303 (72.6)	3441 (70.6)		
No	2301 (28.0)	871 (27.4)	1430 (29.4)		
Children, n (%)				.006[a]	.030[b]
Yes	3582 (43.5)	1476 (45.5)	2106 (42.5)		
No	4620 (56.1)	1765 (54.5)	2855 (57.5)		
Living situation, n (%)				.005[a]	.040[b]
Garden	1832 (22.3)	683 (21.0)	1149 (23.2)		
Balcony	4093 (49.7)	1675 (51.6)	2418 (48.7)		
Garden and balcony	1022 (12.4)	424 (13.1)	598 (12.1)		
None of them	1259 (15.3)	463 (14.3)	796 (16.0)		
Chronic diseases, n (%)				.013[a]	.028[b]
Yes	1804 (21.9)	757 (24.1)	1047 (21.7)		
No	6148 (74.7)	2380 (75.9)	3768 (78.3)		

[a] Chi-square test.
[b] Cramer's V.
[c] Independent t-test; significance level set at ≤.05.
[d] Cohen's d.
[e] SD is standard deviation.
[f] According to chi-square test for SES low vs SES medium to high.

Data analysis

The data analysis was carried out descriptively and inductively with the programme SPSS 27.0. Univariable differences were examined with the help of chi-square tests and t-tests. Effect sizes were calculated using Cohen's d (independent t-test; trivial: <0.2; small: 0.2–0.5; moderate; 0.5–0.8; large: ≥0.8) or Cramer's V (chi-square test; small: 0.06–0.15; moderate: 0.16–0.26; large >0.26) for significant differences in scores and coping answers between IPs and CPs. Multiple linear regression was used to examine possible influencing factors on the coping score. The considered variables contained in our full model were quarantine as IP (=1) or CP (=2), sex (female = 1 and male = 2), age (in years), migration background (no = 1, yes = 2), SES (low and middle = 1 vs high = 2), presence of chronic diseases (yes = 1, no = 2), living situation with balcony and/or garden vs no access to outdoors (yes = 0, no = 1), living with a partner (yes = 1, no = 2) or children (yes = 1, no = 2), psychological distress score, BRS score, physical activity (yes = 1, no = 2) and healthy eating (unhealthier = 1 vs healthier or no change = 2). Variables not contributing to the regression equation were removed via backward elimination. The significance level was set at $\alpha = .05$.

Results

Study population and demographic data

Of the 8232 subjects included, 3256 (39.6%) tested positive for COVID-19, and 4976 (60.4%) were quarantined because they were CPs. Women composed 61.5% of the total sample, 57.5% of the IPs and 64.1% of the CPs. The mean age was 41.6 years (±14.2), and the mean quarantine duration was 11.8 days (±4.6) (see Table 1).

Relative sum scores of coping strategies, resilience and psychological distress

The relative sum scores of the coping strategies and the BRS indicated no significant difference between the two subgroups (see Table 2). In contrast, the sum score of psychological distress averaged 1.1 (±0.7) for IPs and was significantly higher than 1.0 (±0.7) for CPs ($P < .001$). Thus, IPs showed significantly higher psychological distress (see Table 2).

Coping strategies

IPs more frequently stated that they had received offers of support from family, friends or neighbours (item 1; IP: 92.9%, CP: 89.8%) and that they had more exchanges with their social environment via digital media (item 4; IP: 91.0%, CP: 90.0%). They also agreed significantly more often with the statement that they could not do anything themselves to positively influence the situation (item 6; IP: 32.3%, CP: 27.1%). In contrast, they reported having a plan for everyday life less often (item 2; IP: 68.7%, CP: 76.8%) or newly discovered activities that made it easier to stay at home (item 3; IP: 65.9%, CP: 70.1%). Boredom was very heterogeneously distributed in both groups (item 5; IP: 46.4%, CP: 47.0%; n.s.; see Table 3).

Categories

A total of 6292 responses were integrated into the evaluation. Because multiple answers to the question 'What helped you most?' were possible, there were a total of 4059 answers for IPs and 6373 answers for CPs. The most frequently mentioned categories for both groups were contact with the social environment (IP: 47.9%; CP: 39.1%), a positive attitude (IP: 12.5%; CP: 12.6%), hobbies (IP: 10.2%; CP: 12.9%), securing care (IP: 5.4%; CP: 4.7%) and work/study (IP: 4.5%; CP: 8.8%; see Table 4). Institutional care provided by the health office was mentioned by 2.4% of IPs and 0.8% of CPs (see Table 4).

Multiple linear regression

In a stepwise regression, the variables chronic diseases, living with child(ren), living with a partner and migration background were sequentially excluded in the final model. The remaining variables explained 25.9% of the variance (see Table 5). Low psychological distress ($\beta = -0.280$; $P < .001$) as well as a high resilience score ($\beta = 0.139$; $P < .001$) were associated with a higher coping score. The quarantine reason 'tested positive' ($\beta = -0.023$; $P = .034$), female gender ($\beta = -0.106$; $P < .001$), higher age ($\beta = 0.174$; $P < .001$), a high SES ($\beta = 0.042$; $P < .001$), exercise ($\beta = -0.171$; $P < .001$) and unchanged or healthier eating behaviour ($\beta = 0.123$; $P < .001$) showed a positive correlation with the coping score. In addition, a living situation with balcony or garden access correlated with a higher coping score as well. However, this correlation was not found to be significant.

Discussion

To our knowledge, this is one of the first studies to examine coping strategies and their influencing factors in the context of a legally enforced quarantine in Germany. In summary, the IPs reported higher psychological distress than the CPs, though with a small effect size. However, there was no difference in the mean coping score. Approximately three-quarters of participants in the current study used active coping strategies (IP: 76.3%; CP: 74.7%), whereas a much smaller proportion considered extrinsic social or societal factors (IP: 15.5%; CP: 15.9%) or situational factors (IP: 7.3%; CP: 8.6%) to be helpful. The most relevant factors for both the IP and the CP groups were contact with the social environment followed by a positive attitude and engaging in hobbies. Regarding the extrinsic categories, providing for oneself and work or study played the most important roles for both groups. For those in the IP group, the third most important factor was sufficient support from the Cologne health authority (IP: 2.4%; CP: 0.8%); among the CP group, the third most important factor was financial security (IP: 1.1%; CP: 1.2%). Similarly, Fu et al. presented the frequencies of active and passive coping strategies in their study based on an online survey in Wuhan.[6] Overall, a large proportion of respondents (70.2%) reported actively responding to the pandemic. This included participating in activities, talking to others about their concerns and looking at possible positives. Passive coping strategies, such as smoking and depending on others, were used by 29.8%.[6] Singh et al. surveyed

Table 2
Sum scores of coping, resilience and psychological distress.

Sum scores	IP		CP		*P* value[a]	Effect size[b]
	N	Mean (SD)	n	Mean (SD)		
Coping score	3256	4.6 (1.0)	4976	4.6 (1.0)	.091 n.s.	
Brief resilience scale	3229	3.7 (0.8)	4948	3.6 (08)	.202 n.s.	
Psychological distress score	3245	1.1 (0.7)	4962	1.0 (0.7)	<.001	.120

[a] Independent t-test; significance level set at ≤ 0.05.
[b] Cohen's d.

Table 3
Coping items.

Items n (%)	'I do not agree at all' (1)	(2)	(3)	(4)	(5)	'I agree completely' (6)	*P* value[a]	Effect size[b]
I have received offers of support from family, friends or neighbours.							<.001	.097
IP	91 (2.8)	72 (2.2)	67 (2.1)	141 (4.3)	327 (10.1)	2554 (78.5)		
CP	225 (4.5)	150 (3.0)	130 (2.6)	343 (6.9)	641 (12.9)	3479 (70.0)		
I had a plan for my daily life in terms of sleep, work or physical activities.							<.001	.101
IP	449 (13.9)	283 (8.7)	283 (8.7)	484 (15.0)	604 (18.7)	1133 (35.0)		
CP	462 (9.3)	313 (6.3)	374 (7.6)	696 (14.1)	1078 (21.8)	2021 (40.9)		
I discovered activities for myself that made staying at home easier.							<.001	.058
IP	474 (14.7)	324 (10.1)	300 (9.3)	557 (17.3)	634 (19.7)	931 (28.9)		
CP	546 (11.0)	476 (9.6)	454 (9.2)	874 (17.7)	1034 (20.9)	1559 (31.5)		
I have used digital media to communicate with family, friends and acquaintances.							.035	.038
IP	89 (2.7)	86 (2.7)	115 (3.5)	251 (7.7)	635 (19.6)	2066 (63.7)		
CP	141 (2.8)	152 (3.1)	202 (4.1)	435 (8.8)	1050 (21.2)	2975 (60.0)		
I was bored.							.791 n.s.	
IP	843 (26.1)	535 (16.5)	355 (11.0)	575 (17.8)	440 (13.6)	485 (15.0)		
CP	1293 (26.1)	782 (15.8)	545 (11.0)	846 (17.1)	704 (14.2)	778 (15.7)		
I couldn't do anything myself to influence the situation positively.							<.001	.059
IP	1087 (33.6)	696 (21.5)	408 (12.6)	478 (14.8)	267 (8.3)	298 (9.2)		
CP	1822 (36.9)	1149 (23.3)	628 (12.7)	632 (12.8)	355 (7.2)	350 (7.1)		

[a] Chi-square test; significance level set at ≤0.05.
[b] Cramer's V.

Table 4
Descriptive analyses of the free-text answers on coping.

Categories	IP		CP	
	n	%	n	%
Intrinsic categories (active coping)				
Contact with social environment	1943	47.9	2489	39.1
Offering help/responsibility for others	507	12.5	800	12.6
Daily structure	412	10.2	822	12.9
Attitude	59	1.5	245	3.8
Exercise/physical activity	61	1.5	104	1.6
Alcohol/drugs	55	1.4	188	3
Healthy nutrition	28	0.7	45	0.7
Hobbies	15	0.4	33	0.5
Being outside	13	0.3	30	0.5
Avoiding messages related to COVID-19	5	0.1	3	0.1
Extrinsic categories (systemic factors)				
Care by the public health department	217	5.4	301	4.7
Medical care	183	4.5	561	8.8
Securing supplies (food, etc.)	99	2.4	53	.8
Financial security	87	2.1	22	0.4
Work/education	44	1.1	78	1.2
Categories that cannot be influenced (circumstances/situational factors)				
Symptoms and risk factors	118	2.9	94	1.5
Weather	111	2.7	258	4.1
Housing situation	41	1	85	1.3
Transmission	22	0.5	7	0.1
Tests	6	0.2	40	0.6
Length of quarantine	1	0	67	1.1
No answer provided	29	0.7	46	0.7
Other/not attributable	3	0.1	2	0

subjects with suspected COVID-19 infections in India regarding their experiences during institutional quarantine.[39] The vast majority, 80.6%, reported that they perceived support from family and friends as helpful. Having a daily routine (57%), praying (70%) and music (45%) were also reported as other coping strategies.[39]

The results of the COSMO study showed a decrease in the use of coping strategies and general life satisfaction and a simultaneous increase in boredom and perceived helplessness between March 2020 and March 2021.[40] Coping strategies that decreased over time included using the telephone or social media, making plans for daily life and implementing new activities to facilitate staying at home. Furthermore, both offering and receiving support diminished.[40] In the same period, the self-reported perception of stress increased from 51.8% to 56.3%.[40]

In our study, a higher coping score was associated with female gender, higher age, the quarantine reason 'tested positive', a higher SES and resilience score as well as lower psychological distress during stay-at-home order. In addition, a healthy lifestyle, that is, a healthy diet or physical activity during quarantine, had a positive effect on the coping score. Thus, this study at least partially confirms already existing results. In a population-based study by Iddi et al. education and economic class were also significantly related with coping.[41] Furthermore, especially emotion-focused and problem-focused coping strategies were associated with positive moods,[19,42,43] whereas dysfunctional coping strategies were associated with negative moods[43] and higher levels of worry.[44] In contrast, physical activity, following a routine and pursuing hobbies were negatively correlated with depression, anxiety and acute stress symptoms.[3,45] Adaptive coping strategies such as acceptance, reframing and a sense of humour, as well as seeking emotional support showed a negative correlation to psychopathological symptoms.[10]

Moreover, in the overall view of our results, a key function of the health department or care during the quarantine period can be inferred. Being a central contact, the health department has, on the one hand, an advisory function. By addressing possible coping strategies and providing hints to do things such as activating their social networks, citizens' intrinsic coping strategies and resources could be activated. Recommendations regarding a healthy lifestyle such as exercising or using relaxation techniques during the quarantine period should also be addressed in the care. In addition, the office can function as a mediator. It could establish connections between those affected and external support systems, such as everyday or neighbourhood helpers who can ensure that those affected are cared for. It could also establish a special quarantine hotline to make the office accessible to those affected. Corresponding offices have already been established, for example, by the health department of the city of Cologne; this hotline is known as the 'worry phone.' Potential beneficial effects of these measures are also reflected in the free responses on coping. In particular, participants in the IP group mentioned the effective, detailed and empathetic care and information provided by the authorities as a positive factor and coping strategy in itself. Qualified advise could thus avoid the long-term persistence of psychological distress that has already been observed in previous pandemics.[46]

Table 5
Baseline and final model explaining 25.9% of the variance of the coping score.

Models	Independent variables	Standardised regression coefficient β (standard error)	*P* value[a]
Baseline model	Quarantine as IP vs CP	−.022 [.022]	.040
	Age (in years)	.184 [.001]	<.001
	Sex female vs male	−.106 [.022]	<.001
	Migration background no vs yes	−0.011 [.047]	.292 n.s.
	SES medium or low vs high	.043 [.027]	<.001
	Chronical diseases yes vs no	.000 [.025]	.984 n.s.
	Living situation with balcony and/or garden vs no access to outdoors	−.020 [.030]	.072 n.s.
	Living with a partner yes vs no	.011 [.024]	.335 n.s.
	Living with child(ren) yes vs no	−.007 [.026]	.611 n.s.
	Brief resilience scale score	.138 [.015]	<.001
	Psychological disstress score	−.281 [.017]	<.001
	Healthy Eating Index (unhealthier vs healthier or no change)	.122 [.023]	<.001
	Physical activity during quarantine yes vs no	−.167 [.023]	<.001
Final model	Quarantine as IP vs CP	−.022 [.022]	.046
	Age (in years)	.186 [.001]	<.001
	Sex female vs male	−.107 [.022]	<.001
	SES medium or low vs high	.042 [.027]	<.001
	Living situation with balcony and/or garden vs no access to outdoors	−.020 [.029]	.070 n.s.
	Brief resilience scale score	.138 [.015]	<.001
	Psychological disstress score	−.280 [.017]	<.001
	Healthy Eating Index (unhealthier vs healthier or no change)	.122 [.023]	<.001
	Physical activity during quarantine yes vs no	−.167 [.023]	<.001

[a] Linear regression; significance level set at ≤.05.

Strengths and limitations

A clear strength of the present study is its large sample size, which includes a systematically recorded set of Cologne citizens under legally enforced quarantine. Through the possibility of free-text answers, this study also included qualitative questions and thus enabled a detailed insight into the respondents' way of thinking. However, due to the subsequent anonymisation of the inputs, no analysis of the effects of individual coping strategies on the coping score and thus possibly on psychological distress is possible. Thus, this is a purely explorative and descriptive recording of applied mechanisms, which can form the basis for further studies and provides many suggestions for the accompaniment and care of quarantined people.

In addition, the questionnaire was based on the COSMO study so that the results could also be compared with its data. Therefore, items of established questionnaires such as the GAD-7, ADS and IES-R were combined. None of these classic questionnaires was used in their complete psychometrically evaluated form, and the COPE inventory was not used either. A largely stable Cronbach's alpha was found, indicating the internal reliability of our study. External validity, on the other hand, is not verifiable. The reason for this is firstly the complete anonymity of the study, which does not allow a comparison between responders and non-responders, and secondly, the lack of a matched unquarantined control group. Another limitation arises from the fact that the questionnaire was answered mainly by people with a high level of education. Citizens with a migration background are also underrepresented despite translated questionnaires. Furthermore, it should be noted that the participants sometimes answered the questionnaire months after the actual quarantine period. This could have influenced and distorted the answers and assessments given. The influence of the time of the quarantine, the concrete regulations, and the currently prevailing state of knowledge about the coronavirus were also omitted. Causal inferences are only possible to a limited extent due to the cross-sectional design.

Conclusion

In summary, IPs experienced a significantly higher psychological burden than CPs and benefited, above all, from the social environment and from close care during their legally enforced quarantine. In contrast to CPs, IPs more often felt powerless in the face of their situation. Conversely, CPs more often reported making plans for everyday life and finding new activities during their quarantine period.

In addition to providing support and counselling to quarantined people on how to cope with the disease and this crisis, health offices could also act as an interface between those affected and external support systems such as general practitioners and/or psychiatrists. This would give them a key role in combating the pandemic and reducing possible long-term psychological consequences.

Author statements

Ethical approval

The studies involving human participants were reviewed and approved by Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen Human Ethics Research Committee (351/20).

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Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Availability of data and materials

The data sets used and/or analysed in the present study are not publicly available due to the inclusion of sensitive personal data.

Authors' contributions

C.J., B.G., S.F., L.K., A.F., A.K., J.N. and G.W. conducted the study. Data collection was done by L.K., A.F., N.E. and C.G. L.K. and C.J. analysed the data. L.K. and C.J. wrote the manuscript. All authors critically revised the final version of the manuscript.

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Appendix A. Supplementary data

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Corrigendum

Corrigendum to 'Tiered restrictions for COVID-19 in England: Knowledge, motivation and self-reported behaviour' [Public Health 204 (2022) 33–39]

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The authors regret that there are some errors with this manuscript.[1]

There is an issue with labelling for socio-economic grade. The item for this variable asks participants to state the profession of the highest earner in the household. We categorised participants into two groups: highest earner works in a manual occupation, and highest earner does not work in a manual occupation. The levels of these variables are referred to in some of our project's manuscripts as "socio-economic grade C1DE" and "socio-economic grade ABC1" respectively (see Table 1). These would be better denoted as "highest earner in household works in a manual occupation" and "highest earner in household does not work in a manual occupation". This labelling error came about through multiple iterations of documents.

For this study, 482 participants (27.9%) reported that the highest earner in their household worked in a manual occupation (highest earner did not work in a manual occupation: n = 1204, 69.7%; missing data [reported "other" and so could not be categorised]: n = 42, 2.4%). When using socio-economic grade, 764 participants (44.2%) were categorised as belonging to the C2DE group (ABC1: n = 922, 53.4%; missing data: n = 42, 2.4%).

A sensitivity analysis adjusting for socio-economic grade rather than the highest earner being a manual worker indicated that there were no meaningful differences in other analyses investigating the test, trace, and isolate system, and no difference to the conclusions drawn.[2]

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Competing interests

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Table 1
Socio-economic grade variable labelling.

Which of the following best describes the occupation of the member of your household with the largest income (the chief income earner)? Please select one answer Please indicate to which occupational group the Chief Income Earner in your household belongs, or which group fits best. The Chief Income Earner is the person in your household with the largest income. If the Chief Income Earner is retired and has an occupational pension please answer for their most recent occupation. If the Chief Income Earner is not in paid employment but has been out of work for less than 6 months, please answer for their most recent occupation	Labelling as given in manuscript	Amended labelling for manuscript	Socio-economic grade (corrected)
Semi or unskilled manual work (*e.g.* Manual workers, all apprentices to skilled trades, Caretaker, Park keeper, non-HGV driver, shop assistant)	C2DE	Highest earner in household works in a manual occupation	C2DE
Skilled manual worker *(e.g. Skilled Bricklayer, Carpenter, Plumber, Painter, Bus/ Ambulance Driver, HGV driver, AA patrolman, pub/bar worker, etc.)*	C2DE	Highest earner in household works in a manual occupation	C2DE
Supervisory or clerical/junior managerial/professional/administrative *(e.g. Office worker, Student Doctor, Foreman with 25+ employees, salesperson, etc.)*	ABC1	Highest earner in household does not work in a manual occupation	ABC1
Intermediate managerial/professional/administrative *(e.g. Newly qualified (under 3 years) doctor, Solicitor, Board director small organisation, middle manager in large organisation, principle officer in civil service/local government)*	ABC1	Highest earner in household does not work in a manual occupation	ABC1
Higher managerial/professional/administrative *(e.g. Established doctor, Solicitor, Board Director in a large organisation (200+ employees, top level civil servant/public service employee)*	ABC1	Highest earner in household does not work in a manual occupation	ABC1
Student	ABC1	Highest earner in household does not work in a manual occupation	ABC1
Casual worker – not in permanent employment	ABC1	Highest earner in household does not work in a manual occupation	C2DE
Housewife/Homemaker	ABC1	Highest earner in household does not work in a manual occupation	C2DE
Retired and living on state pension	ABC1	Highest earner in household does not work in a manual occupation	C2DE
Unemployed or not working due to long-term sickness	ABC1	Highest earner in household does not work in a manual occupation	C2DE
Full-time carer of another household member	ABC1	Highest earner in household does not work in a manual occupation	C2DE
Other	Missing	Missing	Missing

NHS England; HWWP receives consultancy fees to his employer from Ipsos MORI and has a PhD student who works at and has fees paid by Astra Zeneca. At the time of writing GJR is acting as an expert witness in an unrelated case involving Bayer PLC, supported by LS. NTF is a participant of an independent group advising NHS Digital on the release of patient data. All authors were participants of the UK's Scientific Advisory Group for Emergencies or its subgroups.

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Letter to the Editor

COVID-19 vaccine effectiveness in adults with developmental disabilities living in group homes

This report follows up on our initial description of drive-through vaccination for developmentally disabled adults.[1] In this report, we describe the mortality of a population of developmentally disabled adults in group homes in New York State before and during the implementation of a vaccination program. The impact upon mortality of the available three licensed COVID-19 vaccines is yet to be studied in developmentally disabled adults living in group homes.[2]

Patients with developmental disabilities are uniquely susceptible to COVID-19 based on congregate living conditions and noncompliance with masking and social distancing. They often have comorbidities such as recurrent aspiration pneumonia with resultant chronic lung disease, obesity, diabetes (insulin resistance), and concomitant mental health conditions, which are well recognized additional risk factors for severe COVID-19.[3]

COVID-19 exposure to residents of group homes is amplified due to the number of caretakers (3 shifts/day) and high vaccine hesitancy among caretakers.[4] Group home staff continue to be exempt from vaccine mandates in New York State facilities as of this date in the presence of high levels of COVID-19 infection in the community.[5] Developmentally disabled adults in congregate settings and their staff are designated the highest priority for COVID-19 vaccination due to the increased COVID-19 risk. One-third of COVID-19 deaths occurred in nursing homes, assisted living and congregate settings.[6] Landes et al. (2020)[7] reported a 6.4% mortality from COVID-19 among 543 developmentally disabled residents of group homes from March through October of 2020.

This report describes the change in COVID-19 mortality during the first year of infections (2020) compared to the succeeding year when mRNA vaccinations were implemented. The Pfizer/BioNTech product, Comirnaty®, and the Moderna product, Spikevax®, were primarily used for the vaccination program with a few residents receiving Janssen COVID-19 vaccine. Vaccinations began in January 2021 and were accomplished with home visits and a drive-through program by April 2021. Consent was obtained whenever possible from the patients themselves and when not possible from family or legally constituted surrogates. There were 63 residents whose consenting authority refused vaccination. This allowed the investigators to compare mortality rates between the vaccinated and unvaccinated residents in 2021 in a nonrandomized, observational 'real world' setting.

Study Subjects: Residents of group homes described in this report include people with uncomplicated intellectual disability (IQ < 70), people with developmental disability (low IQ and various genetic conditions), people with both developmental disability and high-risk medical conditions (e.g., seizure disorder, cerebral palsy, obesity, diabetes, chronic lung disease) and people with developmental disabilities and psychiatric/forensic histories. Subjects' ages and sex distribution are displayed in Table 1.

Vaccine records were complete and there were no admissions to the homes during the observation period without COVID-19 vaccination information. Deaths for all residents during the 2 years of observation were reviewed by the authors. COVID-19 contribution to death was confirmed based on history, physical examinations in the hospitals, laboratory testing and imaging in the hospitals. Each death was reviewed on two separate occasions. One review was in the week following the death and again reviewed during the drafting of this paper. COVID-19 was considered to be a contributing cause of death if the pathologic process leading to death included worsening respiratory failure independent of aspiration events or new-onset cardiogenic shock without infarction. No gastrointestinal events led to death and no patient died of stroke during the observation period. Total census figures for December of each year were used for calculations — 679 residents for 2020 and 676 residents for 2021. Confidence intervals were calculated using Clopper-Pearson exact method (see Table 2).

The 8 deaths in 2021 had the following characteristics: four were unvaccinated, two had a single mRNA vaccine dose, and two had two mRNA vaccines 2 weeks or more before the COVID-19 diagnosis. Three unvaccinated patients died before the vaccine campaign began. One patient's family refused COVID-19 vaccination. Total COVID-19 mortality in 2021 in the entire resident population was 1.2%; however, the mortality among the unvaccinated was 9%. Total mortality in 2020 among group home residents was 3.2% when the circulating variants were primarily Alpha and Beta. Our data for analysis of vaccine effect is only based on 2021 data after vaccine was available and the primary circulating variant was Delta. The following can be calculated:[8]

Absolute risk reduction in 2021 once vaccine was introduced was 8.7%. The number needed to treat to prevent one death was 12. Lastly, the COVID-19 vaccine effectiveness at preventing mortality was 97%. We puzzled at the lower total mortality rate for all residents in 2020 compared to 2021 before vaccines were available. The CDC reported that a four-fold mortality increase was observed among unvaccinated persons when Delta variant emerged in 2021.[9] Our experience of a three-fold increase in mortality is consistent with the CDC report and our small sample size.

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Table 1
Age and sex distributions by year of study.

Year	Mean age (yrs) (% over 65 yrs)	Sex (% male)
2020	60 (47% over 65 yrs)	56
2021	63 (43% over 65 yrs)	56

Table 2
COVID-19 mortality by year.

Year	COVID-19 mortality [95% confidence interval]
2020	22/679 = 3.2% [2.0–4.9]
2021	8/676 = 1.2% all residents [0.5–2.3]
	6/67 = 9% unvaccinated residents [6.3–24]

Our vaccine experience confirms the effectiveness of the mRNA vaccines that were administered to the residents. The US Centers for Disease Control provide ongoing monitoring of Vaccine Effectiveness and the most current data (Autumn 2021) shows between 80 and 90% effectiveness at preventing hospitalization.[10] Iannou et al. (2021)[11] published the Veterans Administration elderly subset experience and reported 86% vaccine effectiveness against COVID-19 mortality up through June 2021. Often the cohort of residents of group homes has two or more comorbidities, so we expect a higher mortality rate as well as less vaccine efficacy based on population studies.[12] In addition, we implemented the use of monoclonal antibodies REGEN-COV® (bamlanivimab/etesevimab) and sotrovimab when we had consent and could obtain monoclonal antibodies in the community. We assume severe disease was prevented by their use. This ceased with the Omicron wave in 2021 as the supply of efficacious monoclonal antibodies rapidly dwindled. Consequently, the impact of monoclonal antibody treatment on overall mortality is likely to have been small. Among the potential biases impacting the observed difference in mortality between the vaccinated and unvaccinated residents, prioritization of vaccination for residents who require the most care may have skewed the observations. In addition, potential geographic variations in localized COVID-19 outbreaks may have corresponded to locations where vaccination acceptance was low. This is the first report of vaccine effectiveness in a population of developmentally disabled adults living in group homes and displays robust vaccine effectiveness against mortality from COVID-19.

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Original Research

Post-traumatic stress disorder prevalence and sleep quality in fire victims and rescue workers in southern Brazil: a cross-sectional study☆

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ABSTRACT

Objectives: This survey was conducted to evaluate the prevalence of post-traumatic stress disorder (PTSD) and the sleep quality in victims and rescue team of the third deadliest nightclub fire in the world.
Study design: A cross-sectional study.
Methods: Participants were victims and rescue workers exposed to a fire at a nightclub, which occurred in January 2013 in Southern Brazil. The Pittsburgh Sleep Quality Index (PSQI), composed of seven subjective sleep variables (including daytime dysfunction), and PTSD Checklist – Civilian version (PCL-C) were applied to all people who sought medical attention at the local reference center in the first year after the event. Comprehensive information was obtained concerning sociodemographic factors, health status, and sleep complaints.
Results: A total of 370 individuals, 190 victims and 180 rescue workers, were included. Participants were 70% male, with an average age of 29 years. The prevalence of PTSD was 31.9%, ranging from 24.4% for rescue workers to 38.9% for victims. The prevalence of poor sleep quality was 65.9%, ranging from 56.1% for rescue workers to 75.3% for victims. Most of the participants with PTSD (91.5%) had PSQI scores >5 (poor sleepers), against 54.0% of the non-PTSD individuals. All seven PSQI subscores showed significant differences between PTSD and non-PTSD individuals, especially daytime dysfunction. Sex, shift work, previous psychiatric disease, and sleep quality remained associated with PTSD in adjusted models, with a prevalence ratio (95% CI) of 1.76 (1.28–2.43) in females, 1.73 (1.17–2.55) in shift workers, 1.36 (1.03–1.80) in individuals with psychiatric disease history, and 5.42 (2.55–11.52) in poor sleepers.
Conclusions: The presence of daytime dysfunction increased by at least tenfold the prevalence of PTSD in this sample. Considering that daytime dysfunction was shown to be strongly associated with PTSD, sleep-related issues should be addressed in the assessment of individuals exposed to traumatic events, both victims and rescuers. Factors like shift work and female sex were also associated with PTSD, especially among victims.

Introduction

The Kiss nightclub fire erupted on 27 January 2013 in Santa Maria, a city located in Southern Brazil, killing 242 people and leaving hundreds injured. Most of the victims were university students aged between 18 and 30 years. It is ranked as the third deadliest nightclub fire in the world, topped only by the fire in Luoyang (China) in December 2000, which killed 309 people, and the Cocoanut Grove fire (Boston, USA) in November 1942, which killed 491 people. In addition to being an emotionally traumatic

☆ This work was carried out at Hospital Universitário de Santa Maria and Hospital de Clínicas de Porto Alegre, Brazil.

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event to all survivors, a part of them also experienced physical injuries, such as skin burns and airway damage.

Exposure to traumatic events is a common experience worldwide. According to epidemiologic studies, more than 70% of adults worldwide will experience a traumatic event at some point in their lives, and 30.5% will experience four or more events.[1,2] One of the most prevalent psychiatric consequences of exposure to traumatic events is post-traumatic stress disorder (PTSD). The lifetime prevalence of PTSD depends on social background and country of residence, ranging from 1.0 to 14.0%, with a 1-year prevalence of 0.2 to 3.8%.[2–7] Important PTSD-related symptoms include changes or even disturbances in sleep patterns. Recurrent nightmares and insomnia are the most common distressing sleep symptoms, although other sleep disturbances have been associated with PTSD, including periodic limb movement disorder, rapid-eye-movement sleep behavior disorder, and obstructive sleep apnea.[8,9] Approximately 70% of individuals with PTSD report difficulty in initiating and maintaining sleep.[7,8,10] The prevalence rate of nightmares in PTSD varies because of differences in methodology, ranging from 50 to 96%, the latter in patients with current comorbid panic disorder.[10,11] Nightmares may also predict the subsequent development of PTSD and other psychiatric disorders.[7,10,12–15]

Many factors have been associated with increased susceptibility to PTSD, such as female sex, fewer years of schooling, prior mental disorders, exposure to four or more traumatic events, age at trauma, race, and type of trauma.[2,16,17] The prevalence of PTSD in the first year after a disaster has been documented to range from approximately 25 to 60% among direct victims[18–20] and from 5 to 40% among rescue workers,[21–26] suggesting a higher prevalence of PTSD in direct survivors of disasters than in rescue workers. However, a few studies have compared samples of rescue workers and survivors of a major disaster, allowing direct comparison between the two groups. An example is the study carried out after the 1995 Oklahoma City bombing, where the prevalence of PTSD related to the bombing was significantly lower in rescue workers (13%) than in primary victims (23%).[27]

Studies conducted after traumatic events with countless victims are unique in that they allow researchers to evaluate the emotional response to a traumatic exposure in different groups of individuals, such as rescue workers, survivors, children, and health workers, among others. Thus, the present study was conducted to evaluate the prevalence of PTSD symptoms and sleep quality in individuals exposed to a large nightclub fire that occurred in Southern Brazil. In addition, it was analyzed which subjective sleep data were most related to the presence of PTSD symptoms. The assessments were carried out during the first year after the tragedy and the composition of the sample allowed us to compare the results between victims and rescue/recovery workers. And finally, potential factors associated with PTSD symptoms were identified.

Methods

Study design, setting, and participants

We conducted a cross-sectional survey of individuals (directly or indirectly) exposed to a fire at a nightclub, which occurred in January 2013 in Southern Brazil, as part of a cohort study initiated in 2013. For the present study, only the first evaluations performed during the first year (from February 2013 to January 2014) were considered. The research protocol and the questionnaires — Pittsburgh Sleep Quality Index (PSQI) and PTSD Checklist – Civilian version (PCL-C) — were applied to all individuals who underwent a clinical evaluation at the Pulmonology Service of Hospital Universitário de Santa Maria (HUSM), Brazil. The individuals were referred from the Accident Victims Service Center (CIAVA), a multidisciplinary center specially created at HUSM to care for those involved in the fire. Individuals who could not understand the questions or who had inadequately completed the questionnaires were excluded from the study.

Comprehensive information was obtained concerning sociodemographic factors, general health status, and sleep complaints. For each participant, the following data were recorded: age (on the date of the event), sex, race (self-reported), marital status, level of education, elapsed time of the event, occupational category, smoking status, previous psychiatric disease, groups, type of exposure, and use of psychiatric medications. Data on shift work were collected in later evaluations or by telephone contact. The type of exposure was classified as follows: (a) individuals who were inside the nightclub when the fire started; (b) those who later entered the nightclub; (c) individuals who stood in front of the nightclub; and (d) those who were not at the site of the fire. The aforementioned classification was carried out irrespective of the grouping (victims or rescue workers), and according to the different places of exposure to the event.

Research tools

Sleep quality was estimated based on the validated Brazilian Portuguese version of the PSQI.[28] The PSQI assesses sleep quality over a 1-month period. The questionnaire consists of 19 self-rated questions, categorized into seven components, graded on a score that ranges from 0 to 3. The PSQI components are as follows: subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbances (C5), use of sleep medication (C6), and daytime dysfunction (C7). The sum of the scores for the seven components yields a global score, which ranges from 0 to 21, where higher scores indicate worse sleep quality. Using a cut-off score of 5, the sensitivity and specificity are 89.6% and 86.5%, respectively, for identifying cases with sleep disorder.[29] Thus, participants were considered 'poor sleepers' if the global PSQI score was >5 and 'good sleepers' if $\leq$5.

PTSD symptoms were scored using the validated Brazilian Portuguese version of the PCL-C self-report questionnaire.[30] The 17 items of the PCL-C incorporate the PTSD symptom clusters delineated in the DSM-IV.[31,32] The first five items refer to re-experience symptoms (criterion B), the next seven items refer to emotional avoidance/numbing (criterion C), and the last five items address hyperarousal (criterion D). For this study, we chose the global score to categorize the participants into probable PTSD and non-PTSD. The global PCL-C score ranges from 17 to 85. Participants with a score $\geq$44 were considered to have probable PTSD. Using a cut-off score of 44, the sensitivity and specificity are 94.4% and 86.4%, respectively.[31]

Statistical analysis

Quantitative variables were expressed as mean (SD) or as median (interquartile range [IQR]) when the Kolmogorov–Smirnov test showed asymmetry, and qualitative variables were expressed as percentage values. Two-tailed *P*-values of 0.05 or less were regarded as statistically significant, and 95% confidence intervals (CI) were calculated for the results.

For comparisons between groups, the Chi-squared test or Fisher's exact test was used for qualitative variables, and the Mann–Whitney U test or *t*-test for quantitative variables. A *P*-value <0.05 was considered to be statistically significant.

Poisson regression models with robust variance were used to analyze the adjusted associations among the variables. The following criteria were considered to include covariates in the adjusted regression models: (a) characteristics associated with the

outcome in the univariate analysis; (b) if there was not multicollinearity; and (c) if there was enough frequency in the categories. The predictors of PTSD symptoms in the total study sample were analyzed using the following covariates: sex, group, type of exposure, previous psychiatric disease, shift work, and sleep quality. Predictors of PTSD in victims and rescue workers were also evaluated separately.

The associations between the subjective sleep variables and PTSD were assessed separately, using PTSD as dependent variable. Afterwards, we did an analysis adjusted for PSQI subscores to identify the subjective sleep variables most associated with PTSD.

All analyses were performed by using SPSS for Windows, version 23.0 (SPSS Inc., Chicago, IL).

Ethical aspects

The study protocol was approved by the Research Ethics Committee of Universidade Federal de Santa Maria (UFSM) and subsequently by the Graduate Research Program of Hospital de Clínicas de Porto Alegre (HCPA). All patients signed an informed consent form before their inclusion in the study.

Results

Characteristics of the groups

A total of 370 individuals, 190 victims and 180 rescue workers, directly or indirectly exposed to the fire, underwent a clinical evaluation, properly completed the questionnaires, and signed the informed consent form, being included in the study (Fig. 1). The sociodemographic characteristics of the participants are shown in Table 1.

PSQI and PCL-C scores

Most of the individuals with PTSD (91.5%) had PSQI scores >5 (poor sleepers), against 54.0% of the non-PTSD individuals. The association between subjective sleep data, expressed by the PSQI subscores, and PTSD are shown in Table 2. All seven PSQI subscores showed significant differences between PTSD and non-PTSD individuals. The adjusted prevalence ratio of these sleep parameters according to PTSD status identified daytime dysfunction as the subjective sleep parameter most closely associated with PTSD (Table 2).

The PCL-C and PSQI scores were also analyzed in 31 individuals (8.4%) who had burns, but no significant difference was found when compared to those who did not have burns ($P = 0.226$ and $P = 0.516$, respectively). Similar results were observed in 92 individuals (24.9%) who were hospitalized ($P = 0.331$ and $P = 0.283$, respectively) vs nonhospitalized individuals, and in 56 individuals (15.1%) who lost consciousness at the scene of the fire ($P = 0.274$ and $P = 0.411$, respectively) vs those who did not lose consciousness.

Factors associated with PTSD

The following factors were associated with PTSD: female sex, being a victim, previous history of psychiatric disease, and being inside the nightclub during the fire (Table 3). However, when

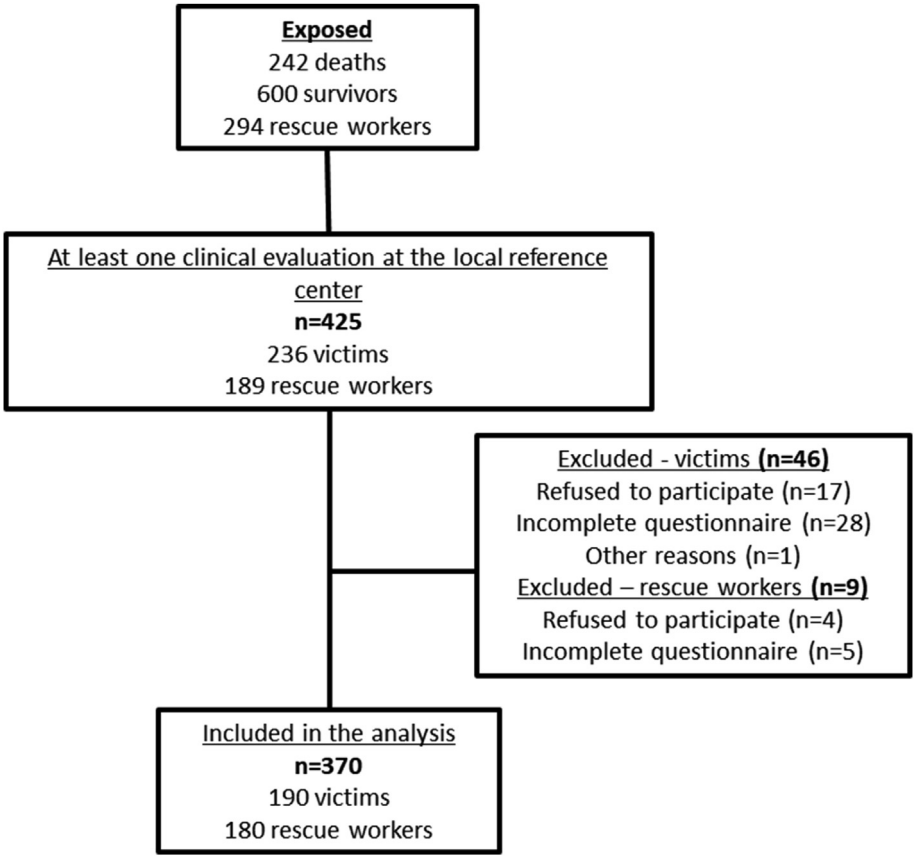

Fig. 1. Flowchart of inclusion and exclusion of patients.

Table 1
Sociodemographic characteristics, presence of PTSD, and sleep quality in victims and rescue workers.

Variable	Total	Victims	Rescue workers	*P*-value[a]
Number of individuals, *n* (%)	370	190 (51.4)	180 (48.6)	–
Male sex, *n* (%)	261 (70.5)	103 (54.2)	158 (87.8)	<0.001
Age (years), mean (SD)	29.46 (9.59)	24.79 (7.98)	34.39 (8.65)	<0.001
Time elapsed since event, *n* (%)				
0–6 months	299 (80.8)	144 (75.8)	155 (86.1)[b]	0.017
7–12 months	71 (19.2)	46 (24.2)[b]	25 (13.9)	
Race, *n* (%)				
White	343 (92.7)	169 (88.9)	174 (96.7)[b]	0.012
Black	6 (1.6)	5 (2.6)	1 (0.6)	
Other	21 (5.7)	16 (8.4)[b]	5 (2.8)	
Marital status, *n* (%)				
Never married	202 (54.6)	165 (86.8)[b]	37 (20.6)	<0.001
Married or cohabiting	145 (39.2)	17 (8.9)	128 (71.1)[b]	
Divorced/Widowed	23 (6.2)	8 (4.2)	15 (8.3)	
Level of education,[c] *n* (%)				
Up to 8 years	13 (3.5)	10 (5.3)	3 (1.7)	<0.001
9–11 years	165 (44.6)	55 (28.9)	110 (61.1)[b]	
>11 years	192 (51.9)	125 (65.8)[b]	67 (37.2)	
Occupational category, *n* (%)				
Student	105 (28.4)	105 (55.3)[b]	–	<0.001
Military police officer[d]	175 (47.3)	–	175 (97.2)[b]	
Security guard/watchman/Civil police officer/prison guard/military	21 (5.7)	16 (8.4)[b]	5 (2.8)	
Associate's degree[e]	24 (6.5)	24 (12.4)[b]	–	
Professional degree[f]	32 (8.6)	32 (16.8)[b]	–	
Other[g]	13 (3.5)	13 (6.8)[b]	–	
Shift work,[h] *n* (%)	124 (40.0)	21 (11.1)	103 (85.1)	<0.001
Smoking status, *n* (%)				
Current smoker	36 (9.7)	23 (12.1)	13 (7.2)	0.007
Never smoked	309 (83.5)	161 (84.7)	148 (82.2)	
Ex-smoker	25 (6.8)	6 (3.2)	19 (10.6)[b]	
Previous psychiatric disease, *n* (%)	52 (14.1)	39 (20.5)	13 (7.2)	<0.001
Type of exposure, *n* (%)				
Far from the nightclub	54 (14.6)	–	54 (30.0)[b]	<0.001
In front of the nightclub	44 (11.9)	17 (8.9)	27 (15.0)	
Later entered the nightclub	99 (26.8)	–	99 (55.0)[b]	
Inside the nightclub	173 (46.8)	173 (91.1)[b]	–	
Use of psychiatric medications,[i] *n* (%)	70 (21.7)	53 (27.9)	17 (12.8)	0.002
PSQI, *n* (%)				
Good sleeper (≤5)	126 (34.1)	47 (24.7)	79 (43.9)	<0.001
Poor sleeper (>5)	244 (65.9)	143 (75.3)	101 (56.1)	
Stress (PCL-C), *n* (%)				
PTSD	118 (31.9)	74 (38.9)	44 (24.4)	0.004
Non-PTSD	252 (68.1)	116 (61.1)	136 (75.6)	

PCL-C = PTSD Checklist – Civilian version; PSQI = Pittsburgh Sleep Quality Index; PTSD = post-traumatic stress disorder; SD = standard deviation.
[a] Qualitative variables were analyzed by the Chi-squared test or Fisher's exact test, whereas quantitative variables were analyzed by the Mann–Whitney U test or *t*-test.
[b] Adjusted residuals >1.96.
[c] The level of education was classified according to years of schooling in Brazil, where the first level corresponds to the period of elementary school, the second level to high school, and the third from college to postgraduation.
[d] Twenty-eight firefighters are included in this category.
[e] An associate's degree includes: agricultural technician, clinical analysis technician, accounting technician, administrative technician, real estate agent, secretary, nursing technician, trade representative, receptionist, and telecommunications technician.
[f] A professional degree includes: administrator, dentist, tourismologist, medical doctor, pharmacist, designer, architect, professor, teacher, civil engineer, veterinarian, physiotherapist, accountant, physical educator, psychologist, environmental engineer, and journalist.
[g] 'Other' includes: cook's assistant, deliveryman, waitress, manicurist, taxi driver, locksmith, agriculturalist, and bricklayer.
[h] Missing = 60; seven staff members of the nightclub who were shift workers are included in the victim group.
[i] Psychiatric medications included antidepressants, antipsychotics, sleep inducers (benzodiazepines and non-benzodiazepines), mood stabilizers, and anticonvulsants. Missing = 47 (all from the rescue worker group).

the values were adjusted, there was an increased PTSD prevalence in shift workers, individuals with previous psychiatric disease, women, and individuals with poor sleep quality. As shown in Table 3, the crude prevalence ratio (95% CI) of 0.95 (0.69–1.32) in shift work was not statistically significant. Shift work was associated with PTSD symptoms only after adjustment, with a prevalence ratio (95% CI) of 1.70 (1.14–2.54) when adjusted for group, 2.06 (1.34–3.17) if adjusted for group and sex, and 1.73 (1.17–2.55) when adjusted for group, sex, type of exposure, previous psychiatric disease, and sleep quality. It is worth noting that most shift workers were men, where a lower prevalence of PTSD was observed in relation to women, and rescue workers, also with a lower prevalence of PTSD when compared to victims.

Differences between victims and rescue workers

In the victim group, the prevalence of PTSD was higher in shift workers (68.2%) than in nonshift workers (35.1%) ($P = 0.006$). This result remained after adjustment for sex, age, marital status, previous psychiatric disease, sleep quality, and shift work, with a prevalence ratio of 1.90 (95% CI, 1.34–2.71). Also, a higher prevalence remained in women, older individuals, and poor sleepers ($P < 0.001$, $P = 0.035$, and $P = 0.004$, respectively).

Table 2
Sleep parameters according to post-traumatic stress disorder (PTSD) status.

Variable	Total	Non-PTSD	PTSD	*P*-value[a]	Crude PR	Adjusted PR[f]
Number of individuals	370	252 (68.1)	118 (31.9)	–	–	
PSQI global[e] (median/interquartile range)	7.00/4.00–10.25	6.00/4.00–8.75	11.00/8.00–14.00	<0.001	1.16 (1.14–1.19)	
Subscore 1 – PSQI						
Subjective sleep quality, *n* (%)						
'Very good'	37 (10.0)	34 (13.5)[b]	3 (2.5)	<0.001	1 (REF.)	1 (REF.)
'Fairly good'	211 (57.0)	170 (67.5)[b]	41 (34.7)		2.40 (0.78–7.34)	0.98 (0.36–2.62)
'Fairly bad'	98 (26.5)	47 (18.7)	51 (43.2)[b]		6.42 (2.13–19.30)	1.39 (0.52–3.75)
'Very bad'	24 (6.5)	1 (0.4)	23 (19.5)[b]		11.82 (3.98–35.08)	2.23 (0.82–6.06)
Subscore 2 – PSQI						
Sleep latency, *n* (%)						
'No difficulty'	63 (17.0)	58 (23.0)[b]	5 (4.2)	<0.001	1 (REF.)	1 (REF.)
'Mild difficulty'	98 (26.5)	82 (32.5)[b]	16 (13.6)		2.06 (0.79–5.34)	1.32 (0.56–3.14)
'Moderate difficulty'	128 (34.6)	79 (31.3)	49 (41.5)		4.82 (2.02–11.50)	1.96 (0.83–4.62)
'Severe difficulty'	81 (21.9)	33 (13.1)	48 (40.7)[b]		7.47 (3.16–17.65)	2.30 (0.97–5.45)
Subscore 3 – PSQI						
Sleep duration, *n* (%)						
>7 h	168 (45.4)	131 (52.0)[b]	37 (31.4)	<0.001	1 (REF.)	1 (REF.)
6–7 h	108 (29.2)	78 (31.0)	30 (25.4)		1.26 (0.83–1.91)	0.77 (0.54–1.10)
5–6 h	66 (17.8)	32 (12.7)	34 (28.8)[b]		2.34 (1.62–3.38)	1.12 (0.78–1.61)
<5 h	28 (7.6)	11 (4.4)	17 (14.4)[b]		2.76 (1.83–4.16)	0.74 (0.47–1.17)
Subscore 4 – PSQI						
Habitual sleep efficiency, *n* (%)						
>85%	202 (54.6)	157 (62.3)[b]	45 (38.1)	<0.001	1 (REF.)	1 (REF.)
75–84%	91 (24.6)	58 (23.0)	33 (28.0)		1.63 (1.12–2.37)	1.21 (0.87–1.69)
65–74%	39 (10.5)	23 (9.1)	16 (13.6)		1.84 (1.17–2.90)	1.11 (0.73–1.69)
<65%	38 (10.3)	14 (5.6)	24 (20.3)[b]		2.84 (1.99–4.04)	1.04 (0.69–1.59)
Subscore 5 – PSQI						
Sleep disturbances, *n* (%)						
'No difficulty'	16 (4.3)	16 (6.3)[b]	–	<0.001	1 (REF.)[g]	1 (REF.)[g]
'Mild difficulty'	169 (45.7)	141 (56.0)[b]	28 (23.7)			
'Moderate difficulty'	158 (42.7)	90 (35.7)	68 (57.6)[b]		2.84 (1.93–4.18)	1.17 (0.78–1.77)
'Severe difficulty'	27 (7.3)	5 (2.0)	22 (18.6)[b]		5.38 (3.66–7.92)	1.30 (0.81–2.07)
Subscore 6 – PSQI						
Use of sleep medication, *n* (%)						
Not during the past month	265 (71.6)	199 (79.0)[b]	66 (55.9)	<0.001	1 (REF.)	1 (REF.)
Less than once a week	26 (7.0)	17 (6.7)	9 (7.6)		1.39 (0.79–2.45)	0.85 (0.49–1.49)
Once or twice a week	28 (7.6)	16 (6.3)	12 (10.2)		1.72 (1.07–2.77)	0.82 (0.55–1.22)
Three or more times a week	51 (13.8)	20 (7.9)	31 (26.3)[b]		2.44 (1.80–3.31)	1.00 (0.74–1.35)
Subscore 7 – PSQI						
Daytime dysfunction, *n* (%)						
'No difficulty'	102 (27.6)	100 (39.7)[b]	2 (1.7)	<0.001	1 (REF.)	1 (REF.)
'Mild difficulty'	136 (36.8)	97 (38.5)	39 (33.1)		14.63 (3.62–59.17)	10.78 (2.59–44.91)
'Moderate difficulty'	92 (24.9)	44 (17.5)	48 (40.7)[b]		26.61 (6.65–106.42)	17.09 (4.17–70.06)
'Severe difficulty'	40 (10.8)	11 (4.4)	29 (24.6)[b]		36.98 (9.25–147.78)	17.04 (4.18–69.54)
PSQI 10[c]						
'Do you have a bed partner or roommate?', *n* (%)						
No	128 (34.8)	89 (35.5)	39 (33.3)	0.351	1 (REF.)	
In other room	30 (8.2)	18 (7.2)	12 (10.3)		1.31 (0.79–2.19)	
In same room, but not same bed	22 (6.0)	12 (4.8)	10 (8.5)		1.49 (0.88–2.53)	
In same bed	188 (51.1)	132 (52.6)	56 (47.9)		0.98 (0.70–1.38)	
PSQI 10a[d]						
Loud snoring, *n* (%)						
Not during the past month	113 (47.5)	84 (52.5)[b]	29 (37.2)	0.005	1 (REF.)	
Less than once a week	39 (16.4)	29 (18.1)	10 (12.8)		1.00 (0.54–1.86)	
Once or twice a week	37 (15.5)	24 (15.0)	13 (16.7)		1.37 (0.80–2.35)	
Three or more times a week	49 (20.6)	23 (14.4)	26 (33.3)[b]		2.07 (1.37–3.11)	
PSQI 10b[d]						
Long pauses between breaths while asleep, *n* (%)						
Not during the past month	202 (84.9)	147 (91.9)[b]	55 (70.5)	0.001	1 (REF.)	
Less than once a week	13 (5.5)	6 (3.8)	7 (9.0)		1.98 (1.14–3.43)	
Once or twice a week	10 (4.2)	3 (1.9)	7 (9.0)[b]		2.57 (1.62–4.09)	
Three or more times a week	13 (5.5)	4 (2.5)	9 (11.5)[b]		2.54 (1.66–3.90)	
PSQI 10c[d]						
Legs twitching or jerking while you sleep, *n* (%)						
Not during the past month	142 (59.7)	113 (70.6)[b]	29 (37.2)	<0.001	1 (REF.)	
Less than once a week	32 (13.4)	22 (13.8)	10 (12.8)		1.53 (0.83–2.81)	
Once or twice a week	35 (14.7)	17 (10.6)	18 (23.1)[b]		2.52 (1.59–3.98)	
Three or more times a week	29 (12.2)	8 (5.0)	21 (26.9)[b]		3.55 (2.39–5.26)	
PSQI 10d[d]						

Table 2 (*continued*)

Variable	Total	Non-PTSD	PTSD	*P*-value[a]	Crude PR	Adjusted PR[f]
Episodes of disorientation or confusion during sleep, *n* (%)						
Not during the past month	166 (69.7)	130 (81.3)[b]	36 (46.2)	<0.001	1 (REF.)	
Less than once a week	34 (14.3)	21 (13.1)	13 (16.7)		1.76 (1.05–2.95)	
Once or twice a week	23 (9.7)	5 (3.1)	18 (23.1)[b]		3.61 (2.52–5.18)	
Three or more times a week	15 (6.3)	4 (2.5)	11 (14.1)[b]		3.38 (2.22–5.15)	

PR = prevalence ratio; PCL-C = PTSD Checklist – Civilian; PSQI = Pittsburgh Sleep Quality Index.
[a] Qualitative variables were analyzed by the Chi-squared test or Fisher's exact test, whereas quantitative variables were analyzed by the Mann–Whitney U test.
[b] Adjusted residuals >1.96.
[c] Missing = 2.
[d] Only individuals who had a bed partner or roommate were included in questions 10a to 10d; Does not apply = 128; Missing = 2.
[e] Asymmetric by the Kolmogorov–Smirnov test ($P < 0.001$).
[f] Adjusted for PSQI Subscore 1, Subscore 2, Subscore 3, Subscore 4, Subscore 5, Subscore 6, and Subscore 7.
[g] The sum of the first and second scores ('no difficulty' and 'mild difficulty') was used as a reference.

Table 3
Predictors of PTSD among the total study sample.

Variable	*N*	PTSD, *n*%	Crude PR[a]	Adjusted PR[a,b]
Number of individuals, *n* (%)	370	118 (31.9)	–	–
Sex				
Male	261	66 (25.3)	1 (REF.)	1 (REF.)
Female	109	52 (47.7)	1.89 (1.42–2.51)	1.76 (1.28–2.43)
Age (in years at event)			1.00 (0.99–1.02)	
Elapsed time after event (months)				
0–6	299	90 (30.1)	1 (REF.)	
7–12	71	28 (39.4)	1.31 (0.94–1.83)	
Race				
White	343	109 (31.8)	1 (REF.)	
Black	6	2 (33.3)	1.05 (0.34–3.29)	
Other	21	7 (33.3)	1.05 (0.56–1.96)	
Marital status				
Never married	202	69 (34.2)	1 (REF.)	
Married or cohabiting	145	39 (26.9)	0.79 (0.57–1.10)	
Divorced/Widowed	23	10 (43.5)	1.27 (0.77–2.11)	
Level of education				
>11 years	192	61 (31.8)	1 (REF.)	
9–11 years	165	50 (30.3)	0.95 (0.67–1.30)	
Up to 8 years	13	7 (53.8)	1.70 (0.98–2.92)	
Occupational category				
Student	105	34 (32.4)	1 (REF)	
Military police officer	175	42 (24.0)	0.74 (0.51–1.09)	
Security guard/watchman/Civil police officer/prison guard/military	21	10 (47.6)	1.47 (0.87–2.49)	
Associate's degree	24	9 (37.5)	1.16 (0.65–2.08)	
Professional degree	32	14 (43.8)	1.35 (0.84–2.18)	
Other	13	9 (69.2)	2.14 (1.36–3.37)	
Groups				
Victims	190	74 (38.9)	1 (REF.)	1 (REF.)
Rescue workers	180	44 (24.4)	0.63 (0.46–0.86)	1.03 (0.50–2.12)
Shift work[c]				
No	186	63 (33.9)	1 (REF.)	1 (REF.)
Yes	124	40 (32.3)	0.95 (0.69–1.32)	1.73 (1.17–2.55)
Smoking status				
Current smoker	36	13 (36.1)	1 (REF.)	
Never smoked	309	93 (30.1)	0.83 (0.52–1.33)	
Ex-smoker	25	12 (48.0)	1.33 (0.73–2.41)	
Previous psychiatric disease				
No	318	92 (28.9)	1 (REF.)	1 (REF.)
Yes	52	26 (50.0)	1.73 (1.25–2.38)	1.36 (1.03–1.80)
Type of exposure				
Far from the nightclub	54	10 (18.5)	1 (REF.)	1 (REF.)
Later entered the nightclub	99	26 (26.3)	1.42 (0.74–2.72)	0.92 (0.42–2.01)
In front of the nightclub	44	15 (34.1)	1.84 (0.92–3.69)	1.47 (0.63–3.41)
Inside the nightclub	173	67 (38.7)	2.09 (1.16–3.77)	1.55 (0.59–4.04)
PSQI				
Good sleeper (≤5)	126	10 (7.9)	1 (REF.)	1 (REF.)
Poor sleeper (>5)	244	108 (44.3)	5.58 (3.03–10.28)	5.42 (2.55–11.52)

PTSD = post-traumatic stress disorder; PR = prevalence ratio; PSQI = Pittsburgh Sleep Quality Index.
[a] Values in parenthesis indicate 95% confidence intervals.
[b] Adjusted for sex, group, type of exposure, previous psychiatric disease, shift work, and sleep quality.
[c] Missing = 60.

In the rescue worker group, a higher prevalence of PTSD was found in poor sleepers and ex-smokers, the latter in comparison with those who never smoked ($P < 0.001$ and $P = 0.034$, respectively). However, only sleep quality remained significant after adjustment for sex, age, shift work, previous psychiatric disease, smoking status, and sleep quality.

The prevalence ratio of PTSD in poor sleepers was 3.45 (95% CI, 1.48–8.02) for victims and 10.59 (95% CI, 2.54–44.20) for rescue workers when adjusted for sex, age, shift work, previous psychiatric disease, and sleep quality. There was no difference in sleep quality between victims and rescue workers in the presence of PTSD. Among non-PTSD individuals, sleep quality was worse in victims than in rescue workers ($P = 0.006$).

Discussion

This study was unique in that it allowed us to assess different groups of individuals, victims and rescue team, with traumatic exposure to one of the deadliest nightclub fires in world history.

Of all exposed individuals, 65.9% were poor sleepers and 31.9% had probable PTSD in the first year after the event, rates similar to those described in the literature for this population.[23,33,34] Most individuals with PTSD were also poor sleepers, which is consistent with the results of a previous study that found sleep disturbances in 70% of the PTSD subjects from an urban general population.[7] However, even in the non-PTSD group, more than 50% had PSQI scores >5 (poor sleepers), a still high rate that may be explained by the possible presence of other psychiatric disorders, such as mood or anxiety disorders, the use of psychiatric medications or even by sleep disturbances associated with stressful life events or occupational stress exposure.[7,35,36]

Sleep disruption following a traumatic event may constitute a specific mechanism involved in the pathophysiology of chronic PTSD and poor clinical outcomes.[37,38] Extant research provides evidence for an association between subjective sleep disturbance and PTSD across diverse trauma samples, including veterans, natural disaster survivors, and mixed trauma samples.[39–44] Individuals with PTSD report more sleep disturbance than both trauma-exposed and healthy controls. Moreover, Lind et al.[45] demonstrated that sleep phenotypes, particularly insomnia symptoms and extremes of sleep duration, have shared genetic etiology with PTSD, indicating potential shared pathophysiology. Although sleep disturbance is typically considered a symptom of PTSD, recent findings suggest that sleep disturbance may predict PTSD symptoms over time. Cox et al.[44] describe two potential roles for sleep disturbance in the development of PTSD: sleep disturbance before a traumatic event may confer vulnerability to developing PTSD; and sleep disturbance following a traumatic event may amplify or prolong typical stress responses and increase the likelihood of the development of PTSD. Furthermore, sleep disturbances in adults with PTSD independently contribute to poor daytime functioning, being a frequent residual complaint after PTSD treatment. Our study showed that daytime dysfunction was the result most closely correlated with PTSD. According to some authors, treatment focusing on sleep can alleviate both sleep disturbances and PTSD symptom severity,[37,46] whereas standard PTSD treatments may conclude with residual sleep disturbance. Pigeon and Gallegos[47] described that nightmares are quite specific to PTSD and tend to ameliorate following standard treatments for PTSD, whereas insomnia is more prevalent and tends to persist if not directly treated. Finally, recent results suggest that intervening on sleep disturbance following trauma exposure could reduce the likelihood of developing PTSD and/or could buffer PTSD symptom severity.[44]

In our study, the factors associated with PTSD were female sex, shift work, poor sleep quality, and previous psychiatric disease after adjustments. Findings on predictors of PTSD clearly point up the heterogeneity of the disorder in different settings. A meta-analysis of risk factors for PTSD in adults demonstrated that sex, age at trauma, and race predicted PTSD in some populations but not in others, whereas education, previous trauma, and general childhood adversity predicted PTSD more consistently.[16] Previous epidemiological studies have demonstrated that PTSD is more likely to occur in women than in men.[4,48–51] Women have been shown to be less likely to experience traumatic events than men, but more likely to experience certain types of trauma that are disproportionately likely to lead to PTSD, such as sexual assault and child sexual abuse.[52] However, even when controlling for sex differences in trauma exposure, women are more vulnerable than men to developing PTSD.[6,51,53] It is not clear whether that is related to differences in the perception of the trauma, in social support, in preexisting depression or anxiety disorders, more common in women, or in other factors that might mediate vulnerability to the trauma.[49,51]

The presence of burns, hospitalization, and loss of consciousness at the scene of the fire were not associated with PTSD in our study. Previous studies have reported that survivors sustaining burn injuries from the fire are not more likely to experience post-traumatic stress symptoms or depressive symptoms than those without burn injuries,[54] suggesting that nonphysical trauma is the primary determinant of these outcomes.[55]

PTSD symptoms were seemingly more frequent in victims than in rescue workers. However, the adjusted prevalence ratio between these groups was not statistically significant. This finding could be partly explained by the differences between groups, such as sex, a factor strongly associated with PTSD. Several studies conducted in the first year after disasters have suggested a higher prevalence of PTSD in direct survivors than in rescue workers.[18–20,22,24–27] Perrin et al.[26] reported that police screening procedures could result in the selection of a more psychologically resilient workforce, supporting other studies that related low levels of resilience to PTSD.[27,56–58] Another possible explanation is that police officers could be more likely to underreport symptoms of psychological distress due to fear of being judged as unable to perform their job responsibilities. However, there are studies demonstrating differences in PTSD prevalence even among disaster workers.[27,59–61] Some factors were associated with increased PTSD prevalence in disaster workers, such as performing tasks outside their training, bereavement and self-identification with the victims, lack of access to mental health services, lack of recognition, and the duration of work at the disaster site.[26,62–65] In the present study, many of the rescue workers performed several different tasks during the event and there was repeated exposure to the scene of the fire by some police officers who were responsible for patrolling the perimeter for several months.

Shift work was associated with PTSD in the present study after adjustment. Shift work has been described to lead to a disruption of circadian rhythm, which in turn can lead to internal de-synchronization,[66] causing significant alterations in sleep and biological functions. Several physical and psychiatric problems that reduce quality of life may occur.[66–71] Existing evidence supports the idea that the circadian clock is vulnerable and/or disturbed in a variety of mental illnesses, including PTSD.[72] Thus, Hasler et al.[73] demonstrated that chronotype is associated with lifetime post-traumatic stress symptoms in combat-exposed military veterans.

Some methodological limitations of this study should be mentioned. One limitation is the cross-sectional design: individuals completed the questionnaires at different time points during the

first year; therefore, the time of onset of symptoms cannot be determined. However, many studies assessing postdisaster PTSD have used a cross-sectional design, despite variations in statistical analysis.[23] Also, we have studied only a convenience sample from a single event that occurred in Brazil and, consequently, our results cannot be generalized to other populations. In addition, data were obtained directly from the participants by self-report questionnaires, potentially introducing a reporting bias. Nevertheless, most of the studies that have demonstrated an association between PTSD and sleep disturbances are based on questionnaires, structured interviews, and self-reported symptoms,[74–77] possibly to facilitate the standardization of data and to simplify data collection. Furthermore, because of the retrospective nature of the analysis, we were unable to measure factors possibly related to PTSD and sleep quality, such as depressive symptoms, substance abuse, previous trauma exposure, and number of trauma exposures, as suggested in the literature.[63,78] Finally, we did not perform objective assessments of sleep in the participants, which would have yielded more specific data on sleep disturbances. Although polysomnography is widely used for objective sleep assessments, it has produced controversial results in PTSD patients.[38]

In conclusion, a high prevalence of PTSD symptoms and poor sleep quality was found during the first year in individuals exposed to a large nightclub fire. The present study provided important information regarding factors associated with PTSD symptoms and their differences between victims and rescue workers, which makes the paper unique. Special attention should be paid to women, individuals with a previous history of psychiatric problems, victims who work in shifts, and present sleep complaints, considering especially the predictive factors of PTSD found in the present study. Daytime dysfunction was the subjective sleep parameter most associated with PTSD. So, sleep-related issues should be addressed in the assessment of individuals exposed to traumatic events, both victims and rescuers. Long-term studies are needed to better understand the relationship between sleep disorders and PTSD, allowing for more effective strategies to screen for PTSD and to determine if early recognition and treatment of sleep disturbances can prevent future PTSD symptoms.

Author statements

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Ethical approval

The study protocol was approved by the Research Ethics Committee of Universidade Federal de Santa Maria (UFSM) and subsequently by the Graduate Research Program of Hospital de Clínicas de Porto Alegre (HCPA), in accordance with international and national guidelines. All patients signed an informed consent form before their inclusion in the study.

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Competing interests

None declared.

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Short Communication

SARS-CoV-2 seroprevalence among people living with HIV in Guinea–Bissau

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ABSTRACT

Objectives: In low-income countries with poor SARS-CoV-2 monitoring and high HIV burden, the prevalence of SARS-CoV-2 is scarcely studied in people living with HIV (PLWH). We set out to measure SARS-CoV-2 seroprevalence in this group.
Study design: Serosurvey of SARS-CoV-2 in PLWH.
Methods: We measured IgG/IgM antibodies using point-of-care rapid tests in 294 PLWH with HIV-1, HIV-2 or HIV-1/2 dual infection at an HIV clinic in Guinea–Bissau between June 1, 2021, and October 1, 2021.
Results: Unvaccinated PLWH ($n = 195$), constituting 66% of the total study population, had a seroprevalence of SARS-CoV-2 antibodies of 27.7%. Of SARS-CoV-2 seropositive unvaccinated PLWH, 71.2% reported no symptoms of COVID-19 since the start of the epidemic up to the inclusion date. Among all participants, 90.1% reported never having been tested for SARS-CoV-2 by any test ($n = 292$). Six participants reported a household death, corresponding to a crude annual death rate of 3.3 per 1000 people.
Conclusions: Despite a low number of officially registered cases of SARS-CoV-2 in Bissau, we found a high seroprevalence of SARS-CoV-2 of 27.7% in unvaccinated PLWH. Coupled with few ever tested for SARS-CoV-2, it indicates that official PCR testing likely underestimates prevalence and that SARS-CoV-2 monitoring is challenged for PLWH. The low number of symptoms from seropositives may stem from survival bias, some effect of herd immunity or, coupled with a low crude annual death rate, that disease symptomatology and severity could be lower than expected.

Introduction

The first case of coronavirus disease of 2019 (COVID-19) in Guinea–Bissau was registered on March 25, 2020.[1] The epidemic has continually been monitored with a low testing capacity. By November 1, 2021, 103,820 people (5.5% of a total population of 1.9 million) had been tested by PCR with 6150 (5.9% of tested people) positive for SARS-CoV-2 and 143 deaths.[2] A recent study from Bissau found SARS-CoV-2 seroprevalence of 18% in healthcare workers.[3] A meta-analysis found a pooled African seroprevalence of SARS-CoV-2 of 22%.[4] Vaccination in Guinea–Bissau started April 2, 2021, prioritizing at-risk groups like people living with HIV (PLWH) using the AstraZeneca vaccine. On August 25, Sinopharm and Johnson vaccines were added to the program and the three vaccines were all administered afterwards. Guinea–Bissau has a high HIV prevalence of 3% nationally[5] and 6.7%[6] in the capital of Bissau. The prevalence of SARS-CoV-2 infection in PLWH in Guinea–Bissau is unknown and we aimed to assess it in this study.

Methods

Participants of the study were PLWH attending follow-up at the HIV clinic at Hospital National Simão Mendes (HNSM) who agreed to participate on the day of follow-up. Initially, an equal amount of HIV-1, HIV-2 and HIV-1/2 dually infected patients was planned to be

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included, but rarity of the two latter led to more HIV-1 inclusions. All participants were aged 18 years or older. Participants were interviewed about demography, lifestyle and COVID-19–related symptoms (fever, cough/sore throat, muscle/joint pain, loss of taste/smell and difficulties breathing), and a drop of blood from the finger was applied to a 2019-nCoV IgG/IgM Rapid Test Cassette (Hangzhou Alltest Biotech Co, Ltd, Hangzhou, China), detecting antibodies to the nucleocapsid protein, to determine SARS-CoV-2 antibody status. Testing and interviews were conducted by local assistants at the clinic. Data collection on SARS-CoV-2 antibody status started June 1, 2021, and ended October 1, 2021.

Results

Sixty-six percent of participants ($n = 195$) were not vaccinated. Among unvaccinated participants, SARS-CoV-2 seroprevalence was 27.7% (see Table 1). Among vaccinated participants ($n = 98$), 73.5% were seropositive ($P = <0.001$).

Analysis of unvaccinated participants

Fifty-four participants (27.7%) tested positive for SARS-CoV-2 antibodies. Among positives, 48 (88.9%) were IgG-positive, 3 (5.5%) were IgM positive and 3 (5.5%) were IgG + IgM positive. No significant difference in SARS-CoV-2 seroprevalence was found between any of the HIV serotypes, different sex, education status or whether people lived inside or outside the capital. Age among seropositives tended to be higher than among seronegatives (49.7% vs 46.4%, $P = 0.07$). A large part of SARS-CoV-2 seropositive participants (71.2%) never experienced any symptoms of COVID-19 from the arrival of the pandemic in Guinea–Bissau on March 25, 2020, up to their day of inclusion between June 1, 2021, and October 1, 2021. For SARS-CoV-2 seronegative patients, 73.3% never experienced any symptoms with no significant difference between the two groups ($P = 0.76$).

Six people reported death in their household during 17 pandemic months with an average reported household size of 6.7 giving a crude annual death rate of 3.3 per 1000 people.

Of unvaccinated patients, 176 (91.2%, $n = 193$) had never received a test for SARS-CoV-2 of any kind. Among all participants, both vaccinated and unvaccinated, 90.1% reported never having been tested for SARS-CoV-2 by any test ($n = 292$).

Discussion

In this serosurvey, 27.7% of unvaccinated PLWH in HNSM Guinea–Bissau tested positive for SARS-CoV-2 antibodies. In comparison, the official number of PCR-confirmed positives (5.9% positivity rate of general population tested) is likely underestimating the magnitude of the epidemic. PLWH in Guinea–Bissau are generally advanced in their disease with low CD4 cell counts when presenting themselves at the clinic and have a high risk of being lost to follow-up.[7,8] Vaccines for COVID-19 are prioritized for this group, but two-thirds of participants had not received a single dose, indicating problems in vaccination efforts. Their advanced status and the low vaccine coverage mean that they could be more at risk of SARS-CoV-2 infection and higher mortality.[9] Unvaccinated seropositive patients reported few symptoms of disease, which could indicate underestimation of SARS-CoV-2 seroprevalence due to survival bias in this group. The low number of reported symptoms and the low crude annual mortality rate (compared to the official Guinean 2018 yearly mortality rate of 9.6/1000 people[10]) could also indicate that PLWH, even those who are generally advanced in their HIV disease, are not necessarily at increased risk of more severe disease, symptomatology or death, or that for now some degree of herd immunity is in effect. The study population consisted only of patients on follow-up, which could underestimate reported symptoms, disease severity and mortality rate due to higher degree of immunosuppression among patients lost to follow-up. Of all participants, very few had ever received a test of any kind to detect SARS-CoV-2. This underlines the general problem of COVID-19 monitoring in the country and for this potential at-risk group specifically.

We found limits in the use of our rapid tests to detect SARS-CoV-2 antibodies because, for instance, Sinopharm will test

Table 1
Differences in baseline characteristics and COVID-19 testing and symptoms between SARS-COV-2 seropositive and seronegative unvaccinated PLWH.

	SARS-CoV-2 seropositive $n = 54$ (27.7%)	SARS-CoV-2 seronegative $n = 141$ (72.3%)	*P*-value
HIV-type			*0.53*
$n = 195$			
HIV-1	19 (35.2%)	62 (43.9%)	
HIV-2	19 (35.2%)	44 (31.2%)	
HIV-dually infected	16 (29.6%)	35 (24.8%)	
Sex			*0.39*
$n = 195$			
Male	12 (22.2%)	40 (28.4%)	
Female	42 (77.8%)	101 (71.6%)	
Age, mean in years	49.7	46.4	*0.07*
$n = 192$			
Area of residence			*0.49*
$n = 195$			
Bissau	48 (88.9%)	120 (85.1%)	
Other	6 (11.1%)	21 (14.9%)	
Any level of education			*0.31*
$n = 195$			
Yes	33 (61.1%)	97 (68.8%)	
No	21 (38.9%)	44 (31.2%)	
Previous COVID-19 test	4 (7.4%)	13 (9.4%)	*0.69*
$n = 193$			
Previous positive test	1 (25.0%)	1 (7.7%)	*0.42*
No symptoms of COVID-19 from start of pandemic up to inclusion	37 (71.2%)	99 (73.3%)	*0.76*
$n = 187$			

positive on a vaccinated participant and AstraZeneca will not. This is because Sinopharm, in contrast to AstraZeneca, generates an antibody response to the nucleocapsid protein, which is what our rapid tests detected. Most vaccinated patients had a positive rapid test, but because of the lack of vaccination data, it is difficult to evaluate if positivity is due to the vaccine or due to endogenous infection, because of the possibility of patients with low CD4 cell count not responding well to the vaccines. Therefore, the analysis focused on unvaccinated patients. Excluding vaccinated patients may underestimate the number of patients tested for SARS-CoV-2 by any test, due to vaccinated patients potentially being more generally informed on health issues and seeking testing when having symptoms. Excluding vaccinated patients benefitting from vaccine-mediated immunity likely increases the seroprevalence of SARS-CoV-2 antibodies derived from infection. However, 66% of the total study population was unvaccinated and the prevalence of SARS-CoV-2 in this group specifically is interesting to help assess the impact of the pandemic on the many who have no vaccine immunity.

In conclusion, our survey found a high seroprevalence of SARS-CoV-2 antibodies in PLWH in an urban African setting. More studies are recommended to understand the impact of SARS-CoV-2 in PLWH in low-income settings, both with regards to the prevalence and overall mortality of PLWH with SARS-CoV-2 compared to the general population. Studies on policymaking on how to best monitor and prevent SARS-CoV-2 in PLWH in similar settings are also recommended, as the epidemic is clearly present and sufficient monitoring and diagnostic efforts are challenged.

Author statements

Authors contributions

AD, CW, JP, CM, BLH and SJ conceived the study; AD, JP and CM carried out data collection; AD, BLH and SJ carried out analysis and interpretation of data. AD and BLH drafted the manuscript; all authors critically revised the manuscript for intellectual content. All authors read and approved the final manuscript of the paper. CW, BLH and SJ are guarantors of the paper.

Ethical approval

This study was approved by the Guinean Ethical Committee (NoRef019/CNES/INASA/2021).

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Competing interests

None declared.

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