DANISH MEDICAL JOURNAL

Original Article

Dan Med J 2020;67(12):A08200594

First wave of COVID-19 did not reach the homeless population in Aarhus

Signe Freja Storgaard[1], Andreas Halgreen Eiset[1], Farhiya Abdullahi[1] & Christian Wejse[1, 2]

1) Department of Public Health, Aarhus, 2) Department of Infectious Disease, Aarhus University Hospital, Aarhus, Denmark

Dan Med J 2020;67(12):A08200594

ABSTRACT

INTRODUCTION: The deadly coronavirus disease 2019 (COVID-19) has rapidly become a pandemic affecting the whole world. Lower health literacy and higher mortality rates in the homeless and vulnerable population compared with the background population potentially leaves this group or people more exposed to COVID-19. This study assessed the vulnerable population of Aarhus in relation to COVID-19 infection.

METHODS: Participants were tested during a six-day period in April and a four-day period in June at drop-in centres, injection rooms and homeless shelters in Aarhus. Oropharyngeal swab tests were performed and analysed with real-time quantitative polymerase chain reaction. Test days in June were supplemented with lateral flow tests for immunoglobulin (Ig) G and IgM. Prevalence and corresponding Wilson 95% confidence intervals were computed.

RESULTS: We tested 295 individuals in April and 141 individuals in June. All oropharyngeal swabs were COVID-19 negative. The lateral flow tests were IgM-positive in six of 129 individuals (4.7%) and IgG-positive less than five of 129 (< 3.9%) individuals. On the day of testing, COVID-19 symptoms such as fever, coughing and/or sore throat were found in 63 of 240 (26.3%) of the participants in April and in 26 of 123 (21.1%) in June. In the April testing round, 175 of 291 (59.9%) reported to be born in Denmark. The corresponding number for the June testing round was 84 of 138 (60.9%).

CONCLUSIONS: Despite their vulnerable profile, the vulnerable citizens tested in Aarhus were not infected with COVID-19 at the testing day and very few participants carried antibodies.

FUNDING: Testing was funded by Aarhus University Hospital.

TRIAL REGISTRATION: not relevant.

In just seven months, the coronavirus disease 2019 (COVID-19) has caused nearly 680,000 deaths, and more than 17,000,000 confirmed cases have been observed [1] since the first COVID-19 pneumoniae was recorded in Wuhan, China, on 31 December 2019. Though COVID-19 is contagious to all humans, some are at special risk of infection and of a severe outcome. Among others, age and co-morbidity have been correlated with poorer outcomes and increased mortality [2]. Refugees and homeless citizens are two population groups that have higher rates of co-morbidity than the background population [3-5]. Non-western migrants were also found to suffer from a higher COVID-19 infection burden than the background population [6, 7]. However, it is important to note that there is no evidence for increased transmission of infectious diseases from refugees and asylum seeking population to the general population [8].

A large part of the homeless population of Aarhus have mental health problems (women: 65% men: 61%), physical health problems (women: 32% men: 25%) or are substance users (women: 51% men: 65%). A large proportion are both substance users and have mental health problems (women: 30% men: 41%). These

demographic characteristics are typical for the homeless population in major cities of Denmark. Homeless people in Aarhus stay mostly with friends and family (39%) or in shelters (28%) and only relatively rarely are they rough sleepers (9%). This is not typical for the homeless population in major Danish cities, where the percentages of rough sleepers and shelter users are generally higher [9].

The number of homeless unregistered migrants in Denmark was estimated to be 519 in 2019, the majority (471) are found in Copenhagen, and only 12 unregistered migrants are estimated to be settled in Aarhus. Unregistered migrants are generally rough sleepers or shelter users [9].

Reducing COVID-19 transmission demands increased attention to hygiene and social distancing and requires a certain degree of health literacy. These are difficult precautions to live by for many homeless and vulnerable citizens (**Table 1**). Furthermore, they are generally a more geographically mobile population group than the background population, wherefore tracking and implementation of preventive initiatives and treatment in the group are challenging.

TABLE 1 / A vulnerable population.

This study defines a vulnerable population as users of test sites: injection rooms, homeless shelters and drop-in centres
The majority of this population are:
Substance users
Homeless people
Refugees and/or undocumented migrants
These 3 population groups are in general:
Of lower socioeconomic status
At an increased risk of mental illness, co-morbidities and of decreased health literacy

Thus, the homeless and vulnerable population is potentially vulnerable to poorer outcomes and higher transmission rates of COVID-19 than the general population. The aim of this study was to assess the prevalence of COVID-19 infection, antibody response to COVID-19 and self-reported symptoms in the homeless and vulnerable population of Aarhus assessed at two time points: in the beginning of the epidemic and several months later when the epidemic would be expected to have reached its maximum.

METHODS

This was a cross-sectional study with data collection during six days in April and four days in June (2020) at drop-in centres, injection rooms and homeless shelters. The sites were chosen in collaboration with the municipality workers and street nurses to maximise the access to the homeless and vulnerable population in Aarhus. Testing events were announced in advance by written notice at the testing sites and orally by the centre staff. All

attendees at testing events were invited to participate regardless of their status. After written and oral consent, participants were invited to complete a short questionnaire, containing questions about self-reported country of origin, co-morbidities, COVID-19 symptoms, previous COVID-19 testing and its result (Appendix 1 https://ugeskriftet.dk/files/a08200594_-_supplementary.pdf).

Oropharyngeal swabs were analysed by real-time quantitative polymerase chain reaction at the Department of Microbiology, Aarhus University Hospital, Denmark. Test days in June were supplemented by a lateral flow antibody test for immunoglobulin (Ig) G and IgM. The lateral flow test was performed using a blood drop from participants' fingertips. Blood was placed on the lateral flow test along with sample dilution. After 15 minutes of incubation, the test provided qualitative information on the presence of IgG and/or IgM towards COVID-19. Clinical validation of the test was carried out in China and showed a diagnostic sensitivity of 98.9% and a diagnostic specificity of 97.6% [10]. Our own validation showed a 100% sensitivity. The oropharyngeal swabs, as well as lateral flow antibody tests, were performed by health professionals.

For the April test round, all individuals were notified of their test result by AHE or CW. In June, assuming predominantly negative test results, participants were notified only in case of a positive test result; this was carefully explained to participants before they gave their informed consent.

Participants were encouraged to wait or return for their lateral flow antibody test result. If participants did not wait or return, they were contacted in case of a positive test result.

The study data were statistically analysed [11, 12], and descriptive statistics were performed [13]. All prevalence estimates are reported with Wilson 95% confidence intervals (95% CI). Missing data were critically appraised with a fraction plot (Appendix 2 https://ugeskriftet.dk/files/a08200594_-_supplementary.pdf) [14].

Trial registration: not relevant.

RESULTS

We tested 295 individuals in April and 141 in June. The median age of the participants was 50 years in April and 53 years in June. The proportion of female participants was 81 of 295 (27.5%) in April and 31 of 141 (22%) in June. More than one in every four reported at least one co-morbidity (April: 85 of 295, 28.8%. June: 48 of 141, 34.0%). Approximately 40% of the participants in both rounds did not report Denmark as their country of origin; the five most commonly reported countries were Greenland (April: 11%, June: 9%), Somalia (April: 4%, June: 5%), Romania (April: 3.4%), Syria (April: 2%, June: 4%) and Poland (June: 3%) (**Table 2**).

TABLE 2 / Characteristics of the study cohort distributed by testing round 1 (April 2020) and round 2 (June 2020).

	Round 1 (N = 295)		Round 2 (N = 141)	
	n/N	median (95% CI)	n/N	median (95% CI)
Age	295/295	50 (38-59) yrs	141/141	53 (42-61) yrs
Sex, female	81/295	27.5 (22.7-32.8)%	31/141	22.0 (15.9-29.5)%
Any co-morbidity	85/295	28.8 (23.9-34.2)%	48/141	34.0 (26.7-42.2)%
Country of birth				
1st	Denmark: 175/291	59.8 (54.1-65.3)%	Denmark: 84/138	60.9 (52.5-68.6)%
2nd	Greenland: 31/280	11.1 (7.9-15.3)%	Greenland: 12/132	9.1 (5.3-15.2)%
3rd	Somalia: 11/280	3.9 (2.2-6.9)%	Somalia: 7/132	5.3 (2.6-10.5)%
4th	Romania: 10/280	3.4 (1.9-6.1)%	Syria: 5/132	3.8 (1.6-8.6)%
5th	Syria: 6/280	2.0 (0.9-4.4)%	Poland: 4/132	3.0 (1.2-7.5)%
Missing				
Born in Denmark	4/295	1.4 (0.5-3.4)%	3/141	2.1 (0.7-6.1)%
Not born in Denmark	11/117	11.3 (6.6-18.8)%	6/48	12.5 (5.9-24.7)%
Previously PCR tested for COVID-19	17/254	6.3 (4.0-9.8)%	92/139	66.2 (58.0-73.5)%
Missing	24/295	8.1 (5.5-11.8)%	2/141	1.4 (0.4-5.0)%
Positive result at previous PCR test	0/17	0%	< 3/87	< 3.4 (1.2-9.7)%
Missing	0/17	0%	5/139	5.4 (2.3-12.1)%
Previously symptoms	NA		16/132	12.1 (7.6-18.8)%
Missing	NA		9/141	6.4 (3.4-11.7)%
Positive PCR-test	0/295	0%	0/141	0%
Self-reported COVID-19-related symptoms	63/240	26.3 (21.1-32.2)%	26/130	20.0 (14.0-27.7)%
Missing	55/295	18.6 (14.6-23.4)%	11/141	7.8 (4.4-13.4)%
Self-reported fever	15/235	6.0 (3.7-9.7)%	8/138	5.8 (3.0-11.0)%
Missing	45/295	15.3 (11.6-19.8)%	3/141	2.1 (0.7-6.1)%
Self-reported cough/throat pain	45/201	18.3 (14.0-23.6)%	23/138	16.7 (11.4-23.8)%
Missing	49/295	16.6 (12.8-21.3)%	3/141	2.1 (0.7-6.1)%
Self-reported other COVID-19 symptoms	29/212	12.0 (8.5-16.7)%	4/124	3.2 (1.3-8.0)%
Missing	54/295	18.3 (14.3-23.1)%	17/141	12.1 (7.7-18.5)%
Antibodies, lateral flow				
IgG- or IgM-positive	NA		6/129	4.7 (2.1-9.8)%
Missing	NA		12/141	8.5 (4.9-14.3)%
Only IgM-positive	NA		6/129	4.7 (2.1-9.8)%
Missing	NA		12/141	8.5 (4.9-14.3)%
Only IgG-positive	NA		< 3/129	< 2.3 (0.8-6.6)%
Missing	NA		12/141	8.5 (4.9-14.3)%

CI = confidence intervals (Wilson); COVID-19 = coronavirus disease 2019; Ig = immunoglobulin; NA = not available, question not asked; PCR = polymerase chain reaction.

All oropharyngeal swabs were negative. The lateral flow test was IgM-positive in six of 129 individuals (4.7%) and IgG-positive in less than three of 129 (< 2.3%) individuals. Symptoms associated with COVID-19 such as fever, coughing and/or sore throat on the day of testing was found in 63 of 240 (26.3%) of participants in April and 26 of 130 (20.0%) participants in June. In June, 16 of 132 (12.1%) of the participants tested reported to have had COVID-19 symptoms at some point since February (Table 2).

For the June testing round, 92 of 139 (66.2%; 95% CI: 58.0-73.5%) reported to have had a polymerase chain reaction (PCR) COVID-19 test once before this testing event; among these fewer than three of 87 (< 3.4%) reported a positive result (Table 2). Additionally, 86 of 139 (61.9%; 95% CI: 53.6-69.5%) reported to have been tested twice before and 15 of 139 (10.8%; 95% CI: 6.6-17.0%) reported to have been tested three or more times before the June testing event. Among the individuals tested more than twice, none recalled a previous positive

result for the COVID-19 PCR test.

The amount of missing data for this study is generally in the 0-8.5% interval. A few categories, "Not born in Denmark" (where participants are asked to specify their country of birth if they were outside of Denmark) and the three questions on self-reported symptoms, had missing data in the 2.1-18.6% range (Table 2). The categories "Result of previous tested, twice" had 75 of 87 (86.2%; 95% CI: 77.4-91.9%) missing values and "Result of previous tested, three times or more" had a missing data percentage of ten of 15 (66.7%; 95% CI: 41.7-84.8%) (Appendix 2 https://ugeskriftet.dk/files/a08200594_-_supplementary.pdf).

To follow the development of the COVID-19 pandemic, oropharyngeal swab testing was repeated for 224 citizens on 24 and 25 August 2020. Again, no positive test results were found.

DISCUSSION

Among the tested homeless and vulnerable citizens, all COVID-19 RNA swabs were negative, and only very few had a positive antibody test (six of 129, 4.7%). A limitation of this study is that it presents a snapshot. This is a limitation introduced by the cross-sectional study design with no follow-up and by the use of oropharyngeal swab tests, which only indicate if COVID-19 RNA is present at the time of testing. This makes it possible to have been infected in-between testing rounds despite testing PCR-negative in our study. The supplement of antibody testing added valuable information about the overall impact of COVID-19 on the vulnerable population of Aarhus.

Our results suggest that COVID-19 is not widespread in the homeless and vulnerable population in Aarhus. Regarding missing data, the categories of age, sex and results of PCR test were complete. On the question of co-morbidities very few (April: 18 of 295, June: zero of 141) participants actually wrote: "no disease", the majority (April: 193 of 295, June: 94 of 141) provided no response, which was interpreted as no co-morbidities, leading to 0% missing data for the co-morbidities question. The result for co-morbidity is in line with the result of a large study of the homeless population [9]. With respect to the reasons for missing data rates in the 1.4-18.6% range, we believe that this is associated with the amount of writing required to answer: the more writing, the more missing data. Questions where only ticking a box was needed ("Born in Denmark", "Previously PCR-tested for COVID-19", "Previously had symptoms of COVID-19") had 1.4-8.1% missing data, whereas questions requiring written answers ("Self-reported symptoms", "Not born in Denmark", "Result of previous PCR test") had missing data in the 2.1-18.6% range. The high percentage of missing data in the categories "Result of previous PCR test, three times or more" (66.7%) and "Result of previous PCR test, twice" (86.2%) may be explained by difficulties recalling retrospective events. However, it is possible that the high percentages of missing data mask positive COVID-19 test results. Contradicting this is the low percentage of missing data in the category "Result of previous PCR test, once", which had very few positive self-reported test results.

We believe that the results of this study are valid despite the missing data. On 26 June, the burden of the disease in the general population in Aarhus municipality was 406 confirmed COVID-19 cases [15], corresponding to a prevalence of 0.116% (116/100,000). The results from our study indicate that the COVID-19 burden in Aarhus is so small that the homeless population, just like the majority of Aarhus, has avoided the disease by coincidence. Alternatively, the homeless population may be so isolated in society that this produces a protective effect against the COVID-19 pandemic. This isolating protective effect of the homeless population has also been reported in other studies, e.g., in Hamilton, Canada, where 1% of the tested shelter residents were COVID-19-positive compared with 5-7% in the general population [16]. Likewise, during the 2009 H1N1 pandemic in Mexico [17] and for other respiratory infections in France [18], the homeless population was less directly affected than the background population, indicating an isolating protective effect. This being said, studies from the US show a higher prevalence of COVID-19 infections in the homeless population than in the background population,

varying from city to city [19].

Whether these differences are a reflection of different compound societies or if it is a question of reaching a certain disease burden in the population before infection also reaches the homeless people cannot be determined by this paper. In 2019, it was estimated that 750 homeless people were living in Aarhus [9]. We have tested 436 unique individuals, meaning that we have potentially tested 58% (436 of 750) of the homeless. That being said, it was not confirmed if participants did, in fact, belong to the general group of homeless people. Nonetheless, testing sites were chosen carefully and street nurses from the municipality confirmed that the included study population did meet our inclusion criteria, but also noted that some of the most severe intravenous drug users did not show up. Therefore, it might only be possible to generalise the results to testing-site users. The demographics of the tested population seem very accurate in terms of age, sex and country of origin when compared to known demographic information on the homeless population of Aarhus [9].

In this study, 29-34% answered that they had one or more diseases; approximately 2% of those reported psychiatric diagnoses. Known data from Aarhus show that 25-32% suffer from a somatic disease and that 61-65% have mental illness. Hence, it seems that participants underreported psychiatric diagnoses, which is often seen [20]. This supports that the tested population is representative of the homeless and vulnerable population of Aarhus. During the drafting of this paper, the infection rate in Aarhus Municipality increased, particularly in the Somali and Lebanese minorities; in week 32, the Somali minority made up 52% (179 of 341) of the COVID-19 cases in Aarhus [7]; the Somali population represents 1.3% (4,724 of 349,983) of the total population of Aarhus. In our testing round, Somalia was the most frequently reported country of origin, except for Denmark and Greenland (Table 2). A significant characteristic of the homeless immigrants and second-generation immigrants is that they are more likely to stay with family and friends than to be rough sleepers or shelter users [9]. This could potentially have allowed COVID-19 to enter the homeless and vulnerable population. Despite the increased infection burden in Aarhus and particularly in ethnic minorities, the 224 homeless and vulnerable people tested on 24 and 25 August all tested negative to COVID-19.

CONCLUSIONS

Homeless and vulnerable people are traditionally considered to be at increased risk of COVID-19 transmission. However, none of the people tested in this study had become infected by COVID-19 on their testing day until June 2020, and very few showed evidence of previous exposure as indicated by the presence of an immune response.

CORRESPONDENCE: *Signe Freja Storgaard.* E-mail: sist@ph.au.dk

ACCEPTED: 27 October 2020

CONFLICTS OF INTEREST: none. Disclosure forms provided by the authors are available with the full text of this article at Ugeskriftet.dk/dmj

LITERATURE

1. Johns Hopkins University. COVID-19 dashboard. https://coronavirus.jhu.edu/map.html (31 Jul 2020).
2. Yang J, Zheng Y, Gou X et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis. Int J Infect Dis 2020;94:91-5.
3. Aldridge RW, Story A, Hwang SW et al. Morbidity and mortality in homeless individuals, prisoners, sex workers, and individuals with substance use disorders in high-income countries: a systematic review and meta-analysis. Lancet

2018;391:241-50.

4. Eiset AH, Aoun MP, Haddad RS et al. Asylum seekers' and Refugees' Changing Health (ARCH) study protocol: an observational study in Lebanon and Denmark to assess health implications of long-distance migration on communicable and non-communicable diseases and mental health. BMJ Open 2020;10:e034412.
5. Taleshan N, Petersen JH, Schioetz ML et al. Multimorbidity and mortality thereof, among non-western refugees and family reunification immigrants in Denmark - a register based cohort study. BMC Public Health 2018;18:844.
6. Antallet af påviste tilfælde af COVID-19 stagnerede i uge 30. www.ssi.dk/aktuelt/nyheder/2020/2020_7_covid-19_uge23-30 (3 Aug 2020).
7. Smittetallet steg yderligere i uge 32. www.ssi.dk/aktuelt/nyheder/2020/smittetallet-steg-yderligere--i-uge-32 (12 Sep 2020).
8. Eiset AH, Wejse C. Review of infectious diseases in refugees and asylum seekers-current status and going forward. Public Health Rev 2017;38:22.
9. Det Nationale Forsknings- og Analysecenter for Velfærd. Hjemløshed i Danmark 2019. www.vive.dk/da/udgivelser/hjemloeshed-i-danmark-2019-14218/ (29 Jun 2020).
10. Beijing Aipuyi Medical Inspection Center. Appendix 14 YZ/R-011/CG25 Clinical Validation, 2020.
11. Harris PA, Taylor R, Thielke R et al. Research electronic data capture (REDCap) - a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377-81.
12. R Core Team. R: a language and environment for statistical computing. 2020. www.R-project.org/ (17 Aug 2020).
13. Signorell A, Wickham H, Harrell Jr F et al. DescTools: tools for descriptive statistics. 2020. https://cran.r-project.org/package=DescTools (17 Aug 2020).
14. Wickham H. ggplot2: elegant graphics for data analysis. 2016. https://ggplot2.tidyverse.org (17 Aug 2020).
15. Overvågning af COVID-19. www.ssi.dk/sygdomme-beredskab-og-forskning/sygdomsovervaagning/c/covid19-overvaagning (26 Jun 2020).
16. Bodkin C, Mokashi V, Beal K et al. Pandemic planning in homeless shelters: a pilot study of a COVID-19 testing and support program to mitigate the risk of COVID-19 outbreaks in congregate settings. Clin Infect Dis (online 8 Jun 2020).
17. Rodwell TC, Robertson AM, Aguirre N et al. Pandemic (H1N1) 2009 surveillance in marginalized populations, Tijuana, Mexico. Emerg Infect Dis 2010;16:1292-5.
18. Thiberville SD, Salez N, Benkouiten S et al. Respiratory viruses within homeless shelters in Marseille, France. BMC Res Notes 2014;7:81.
19. Mosites E, Parker EM, Clarke KEN et al. Assessment of SARS-CoV-2 infection prevalence in homeless shelters - four U.S. Cities, March 27-April 15, 2020. MMWR Morb Mortal Wkly Rep 2020;69:521-2.
20. Takayanagi Y, Spira AP, Roth KB et al. Accuracy of reports of lifetime mental and physical disorders: results from the Baltimore Epidemiological Catchment Area study. JAMA Psych 2014;71:273-80.