Sero-prevalence of SARS-CoV-2 Antibody Among Adults in the General Population in Diredawa, Ethiopia

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Research Article

Keywords: Adults, Diredawa, Ethiopia, SARS-CoV-2, Sero-prevalence

Posted Date: March 2nd, 2021

DOI: https://doi.org/10.21203/rs.3.rs-266413/v1

Abstract

Background: Determining the extent of seropositivity of SARS-CoV-2 antibody has the potential to guide prevention and control efforts. We aimed to determine the sero prevalence of SARS-CoV-2 antibody among adults in the general population of Diredawa, Ethiopia.

Method: Community based cross-sectional survey was conducted among random sample of 648 adult population in Diredawa from June 15 to July 30, 2020 using interview and blood sample collection. Participants were asked about demographic characteristics, COVID-19 symptoms and adherence to preventive measures. Sero-prevalence was determined using SARS-CoV-2 IgG test.

Result: The estimated SARS-CoV-2 prevalence was 3.2% (95 % CI: 2.0 - 4.8) in the study region with no differences by age and sex but considerable differences were observed by adherence to COVID-19 preventive recommendations. For instance, the prevalence of SARS-CoV-2 among participants who reported not to have practiced social distancing measures was 8.5 times the prevalence in their counterparts who reported of practicing social distancing. The corresponding estimates were 12.8 (95%CI, 7.0, 19) and 1.5 (95% CI, 0.5, 2.5) with statistically significant difference(p<0.01). Similarly, we observed 4.5 times higher prevalence among people who reported of not wearing face masks and who mentioned of not avoiding social gatherings. More than 80 percent of study participants reported of adherence to infection prevention measures (face masks and physical distancing recommendations).

Conclusion: The SARS-CoV-2 sero-prevalence detected among adults in Diredawa was low and indicates much higher proportion of population not yet infected. COVID-19 preventive measures are associated with reduced prevalence and should be promoted to avoid transmission to the uninfected majority.

Introduction

Coronavirus disease 2019 (COVID-19) emerged from Wuhan, China, in December 2019 as a novel respiratory illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Subsequently, it was declared as a pandemic that is a threat for every country in mid-March 2020 by the World Health Organization (WHO) [1]. Since then, the disease has claimed millions of lives and has crippled economy and health throughout the world. The spectrum of SARS-CoV-2 severity varies broadly, from asymptomatic infection to severe complication like organ failure and death [2, 3].

Ethiopia reported the first case in March 2020, and subsequently identified the epicentre at the national capital Addis Ababa, meanwhile clusters were also detected in the regional capitals including Diredawa. Since then, there were over 150,000 cases and more than 2, 000 deaths from COVID-19 in Ethiopia [4], but the actual prevalence of disease and infection have not been measured [5, 6, 7].

Population level COVID-19 prevalence can allow inferences to be made about the extent of infection [8, 9, 10, 11]. These findings can have the potential to guide local preventive or control measures [12, 13, 14, 15]. Population level seroprevalence studies also provide the magnitude of population who have not yet

been infected, a vital information to plan for future transmission control measures and health-care needs. Therefore, this survey was designed to measure the prevalence of SARS-CoV-2 infection in general population of Diredawa region, which shares borders with other countries, including Djibouti, where there is high population movement and high-risk social interactions. Data from this survey will serve as a benchmark to show changes in transmission rates in the studied population across time.

Methods

Design, setting and population

This study was part of the nationwide SARS-CoV-2 survey conducted in Ethiopia from mid-June to end of July 2020. We analyzed survey data of 684 adults aged 15 years and above residing in Diredawa administrative region, which is one of the eleven regional states in Ethiopia. Diredawa is located 515 km from the national capital, Addis Ababa to the east. The current total population of Diredawa is 506, 936 based on population projection using 2007 census. Diredawa administration regional health bureau was among the other sectors to engage early into the establishment of emergency operation centers and task forces following the first documented COVID 19 case in Addis Ababa on March 13,2020.

SARS-CoV-2 survey was conducted among adults above the age of 15 years residing in randomly selected households from purposively selected 11 neighborhoods with relative overcrowding as defined by Ethiopian population and housing census bureau. Sero data for 684 study participants was received from Ethiopian public health institute national COVID-19 laboratory. Before data analysis, we reviewed similar other studies to check whether the available sample size (n=684) is sufficient for analysis. By considering, sero- prevalence of SARS-CoV-2 from different population level prevalence studies conducted in Addis Ababa [16], China [17], and Brazil [18] and Iran [19], the expected sample size in our study setting would be 123, 110, 123, 660, respectively assuming margin of error of 5 percent at 95 percent confidence level. Hence, the sample size in our study is much larger. At the time of survey, schools were closed, and social gatherings including religious congregations were restricted in Ethiopia.

Data collection tool, procedure and quality control

List of 1881 households was received from the purposely selected 11 enumeration sites. Nationally allocated quota was proportionally distributed to these sites depending on the total number of households available at each enumeration site. Data were collected from adults residing in the selected households by trained data collectors both on electronic data collection forms using tools adopted from similar other studies [10] and venous blood samples were collected by trained laboratory technicians, nurses and medical doctors. Open Data Kit (ODK) and Research Electronic Data Capture (REDCap) were used to collect data electronically. Participants were asked history of symptoms compatible with COVID-19 (fever, chills, fatigue, myalgia, sore throat, cough, shortness of breath, chest pain, headache, nausea, vomiting, headache and anosmia). They were also asked about contact with suspected or confirmed cases and adherence to COVID-19 prevention measures (i.e. wearing face masks, social distancing and others). Venous bloods were stored in cold chain (15-30 degree centigrade) and shipped to the central

laboratory by the regional coordinators at the same day of blood sample collection. In addition, refrigerator temperature requirement for the SARS-CoV-2 IgG assay was monitored on samples of each day of use based on the manufacture's instruction. Specimen shipment, package and label were conducted in compliance with applicable and available national and international regulations covering the transport of clinical specimens and infectious substances. Data were collected after written informed consent was obtained from survey participants. For participants less than 18 years of age, the parent or guardian was asked to participate on behalf of the child. Permission to publish this study is obtained from Diredawa Regional health bureau.

Detection of SARS-CoV-2 IgG antibodies

Serum samples were processed on the Abbott Architect instrument using the Abbott SARS-CoV-2 IgG assay following manufacturer's instructions (SARS-CoV-2 IgG for use with ARCHITECT; Abbott Laboratories, Abbott Park, IL, USA) [20]. The assay is a chemiluminescent micro-particle immunoassay for qualitative detection of IgG in human serum or plasma against the SARS-CoV-2 nucleoprotein. The IgG antibodies to SARS-CoV-2 in each sample were determined by comparing the chemiluminescent relative light unit (RLU) in the samples to the calibrator RLU. Samples were deemed positive if the index values are above the manufacturer's recommended cut off value of 1.40. Using an index S/C threshold of 1·4, the manufacturer reported a sensitivity of 86·4% after 7 days from symptom onset and 100% after 14 days, and a specificity of 99·6%, using RT-PCR as the gold standard. The algorithm has sensitivity of 0 for infections with symptom onset of less than 3 days [10].

Statistical analysis

We estimated seroprevalence as the proportion of individuals who had a positive result for IgG antibody. As the study participants did not report COVID-19 symptoms, we didn't adjust results for sensitivity of the test. Estimates of overall prevalence and the 95% uncertainty range has been generated using Stata 14 [21]. Similarly, prevalence estimates along with their 95% confidence intervals (CI) were also provided for selected demographic and other risk factors.

Results

Socio demographic characteristics of study participants

Data were analysed for a total of 684 study participants. The mean age of the study participants was 37. 6(SD = 15.6 years). Majority of the participants 313 (45.8%) were in the age category of 25–44 years followed by 213 (31.3%) older than 45 years Table 1.

Table 1
Selected sociodemographic characteristics of study participants for SARS-C-oV-2 Seroprevalence, Diredawa, East Ethiopia, 2020.

Characteristics	Category	N (%)
Age (N = 684)	≤ 24	158 (23.1)
	25–44	313 (45.8)
	≥ 45	213 (31.3)
Sex (N = 684)	Male	307 (44.9)
	Female	377 (55.1)
Occupation (N = 684)	Employed	370 (54.1)
	Jobless	314 (45.9)
Education (N = 682)	No formal education	65 (9.5)
	Primary education	201 (29.4)
	Secondary education	296 (43.3)
	Technical or higher education	120 (17.5)

Behavioural and clinical characteristics

When asked about practicing physical distancing recommendations, more than four fifth 558 (81%) of the respondents did report practicing of physical distancing recommendations; of which 344 (60%) did often practice the recommended physical distancing rule (result not shown) [Table 2]. Similarly, from the overall respondents 583 (85.6%) use face mask while leaving home, 582 (85.5%) avoid religious or other social gatherings involving more than four individuals outside of their households/residence and only 119 (17.6%) did report hand washing practice and use of sanitizers frequently. Concerning main COVID 19 symptoms, all the interviewed respondents didn't show any COVID 19 related symptoms including history of fever, chills, fatigue, muscle ache (myalgia), sore throat cough and known history of contact with anyone with suspected or confirmed COVID-19 patient from the time the first COVID 19 case was documented in Diredawa until this survey data was collected.

Table 2
Selected clinical and behavioral characteristics of study participants for SARS-C-oV-2 Seroprevalence, Diredawa, East Ethiopia, 2020.

Behavioural characteristics against COVID-19	Number (%)
Practice physical distancing recommendations (n = 681)	558 (81.9)
Wash hand or use sanitizers (n = 677)	120(17.7)
Avoid religious or other social gatherings (n = 681)	582(85.5)
Use face mask while leaving home (n = 681)	583 (85.6)

Seroprevalence of SARS-CoV-2

During the study period, the prevalence of SARS-CoV-2 IgG antibody was 3.2%, 95%CI: 95 % CI: 2.0–4.8). Our prevalence estimates did not vary by age and sex (Table 3). However, marked differences were observed in the estimated prevalence by adherence to behavioural characteristics. The prevalence of SARS-CoV-2 among participants who reported not to have practiced social distancing was 8.5 times the prevalence in their counterparts who reported of practicing social distancing. The corresponding estimates were 12.8 (95%CI, 7.0, 19) and was 1.5 (95% CI, 0.5, 2.5) with statistically significant difference ($p < 0.01$).

Similarly, we observed 4.5 times higher prevalence among individuals who did not wear facemasks, 10.1% (95% CI: 4.1, 16)) compared to individuals who reported of wearing them, 2.3% (95% CI: 1.0, 4.0) when living home. Participation in social gatherings which involve more than 4 people is linked to increased prevalence. In this study, we estimated a prevalence of 10.0% (95% 4.0, 16) among individuals who did not avoid social gatherings which is 4.5 times higher compared to prevalence among individuals who avoided social gathering events. However, we could not detect a statistically significance difference in the prevalence of SARS-CoV-2 by hand washing practice ($p = 0.25$) (Table 3). With regards to employment, the prevalence of COVID 19 among individuals who were employed and work by moving from home to work area was high. Individuals who were employed and commute between work and home had estimated prevalence of 5.4 (95%CI, 0.03–0.08) compared to individuals who reported no employment 0.1 (95%CI, 0.1–2.1). This observed difference between the two categories of employment status was statistically significant ($p = 0.001$).

Table 3
Analysis of SARS-CoV-2 seropositivity by selected factors among adult residents of Diredawa administration, Diredawa, Ethiopia, 2020.

Variables	Categories	Prevalence (95%CI)	P-Value
Age in years	15–24	5.4 (2.0, 9.0)	*p = 0.10*
	≥ 25	2.7 (1.0, 4.0)	
Sex	Male	3.4 (1.0, 5.0)	p = 0.96
	Female	3.3 (1.0, 5.0)	
Employment status	Employed	5.4 (3.0, 8.0)	< 0.01
	Not employed	0.9 (0.1, 2.0)	
Use face cover while leaving home	Yes	2.3 (1.0, 4.0)	p < 0.001
	No	10.1 (4.1, 16)	
Avoid going to crowds	Yes	2.3 (1.0, 4.0)	p < 0.001
	No	10.0 (4.0, 16)	
Practice physical distancing	Yes	1.5 (0.5, 2.5)	p < 0.0001
	No	12.8 (7, 19)	
Frequent hand washing /use of sanitizer	Yes	5.1 (1.0, 9.0)	p = 0.25
	No	3.0 (2, 4.0)	

Discussion

In this survey, the estimated seroprevalence of SARS-CoV-2 is 3.2 percent among adult population in the study setting. The large proportion of population (close to 97 percent) not yet infected at the time of survey meant that promotion of COVID-19 recommended prevention and control measures would be vital to interrupt the continued community transmission [22].

The prevalence in our study was generally lower than expected which can be attributed to higher adherence rates among our study participants to COVID 19 preventive measures. When the study was undertaken, population level measures that include school closure, restrictions on social gatherings and physical distancing rules were in place in Ethiopia. However, the estimated SARS-CoV-2 antibody by IgG was higher compared to studies conducted in Wuhan [17] and meta-analysis of global pooled sero-prevalence [23]; but lower compared to other studies conducted at Addis Ababa [16], Brazil [18] and Iran [19]. The observed differences might be due to differences in the stages of the pandemic at the time of the surveys, with surveys conducted at the earlier stage of the pandemic more likely to report lower prevalence compared to those conducted at the later stage. Another main source of difference is the

presence of and level of enforcement of population level government restrictions against COVID-19 to limit transmission.

Consistent with a study from Brazil [18], we could not detect significant difference in IgG prevalence by sex an age category. Although such lack of effect of age could be related to our particular choice of age category, the differences mean that the risk of getting infection might not vary by sex and age. The importance of those variables might be on the progression of and outcome of disease once infection has occurred.

None of the study participant reported symptoms compatible with COVID-19 and contact with a known COVID-19 case. So, the prevalence observed in this study might be caused predominantly by asymptomatic community transmission. This underlies the importance of promoting COVID-19 preventive measures such as wearing face mask and physical distancing to cut the asymptomatic transmission in the population. However, although it may be argued that lack of symptoms compatible COVID-19 is partly related to recall bias, the role of this bias may not be substantial in our study setting. The main reason is that this study was conducted in a city administration, where residents have exposure to information regarding the symptoms and preventive measures through mainstream media as well local means. Besides there were strong restrictions imposed at different stages of the pandemic. These all measures meant that symptoms are less likely to be forgotten. In addition, higher adherence rates (more than 80% for most measures) to COVID-19 measures in our study supports our assertion that the study population has good awareness of the disease.

In this study, the prevalence of SARS-CoV-2 was significantly higher among individuals who were employed and commute from home to work and back again compared to those working from home or jobless and is consistent with other studies [8, 24, 25]. Employment often requires frequent movement and close social interactions and therefore can increase the risk of asymptomatic transmission of SARS-CoV-2.

In our study, adherence to COVID-19 prevention recommendations has critical role in interrupting transmission. In particular, we observed 8.5 times higher prevalence among individuals who do not practice the recommended physical distancing measures. Our finding replicates findings from a meta-analysis [26]. However, such effects were not reported in [25, 28] probably related to the epidemic stage and different state of restrictions at the time these studies.

We also observed, 4.5 times higher prevalence among respondents not frequently using face mask while leaving homes compared to those who frequently use it. Consistent with other studies, this study found higher sero-prevalence among those who do not frequently use face masks [25]. In Ethiopia and in our study setting, wearing face mask has become mandatory from the early stages of the epidemic.

Similarly, the prevalence of SARS-CoV-2 among study participants who did not avoid going to crowds involving more than four people was more than four times higher compared to those who avoided going to crowds involving more than four people. This finding is consistent with a previous study that indicated

disproportionately higher prevalence in individuals involved in crowds [23]. However, we failed to detect significant differences in SARS-CoV-2 seroprevalence by hand washing practice.

Our study has several limitations. The performance of the test depends on time since infection, with limited sensitivity for recent infections. At the earlier stage of the infection, individuals may not yet be able produce detectable antibodies. As, a result, it is likely that the estimated prevalence can be underestimated. Although, it was possible to adjust for such variations of test performance by time since infection, we could not adjust our estimates to the sensitivity as none of our study participants reported symptoms compatible with COVID-19.

Responses regarding COVID-19 recommended preventive measures were subjective self-reports. It is likely that individuals might not always maintain the recommended physical distance and proper mask wearing but can still positively report causing social desirability bias.

Conclusions

In conclusion, the findings of this study imply that prevalence of COVID-19 is low, indicating larger proportion of population is yet to be infected. We also found that the COVID-19 measures have significantly cut transmission within the community. Therefore, it is essential to promote and strengthen the recommended COVID 19 preventive measures to cut transmissions with in the community.

List Of Abbreviations

IRB; Institutional Review Board, SARS-CoV-2; Severe Acute Respiratory Syndrome Coronavirus 2, SOP; Standard Operating Procedures

Declarations

Ethical statement

Ethical clearance letter was obtained from IRB of Diredawa Administration regional health bureau. In addition, written informed consent was obtained from all survey participants. For participants less than 18 years old, the parent or guardian were asked to participate on behalf of the child. Survey participants were informed of the nature of this evaluation and their freedom to participate. Any participant was given full right to opt out of the survey at any point during the administration of the questionnaire or collection of venous blood. The voluntary nature of this survey was emphasized and participants were free to refuse to answer any question(s) and to end their participation at any time. Informed consent documents were administered in the appropriate local language.

Consent for publication

Not applicable

Availability of data and materials

All data related to this study are available in the manuscript

Competing interest

None to declare

Funding

This study was funded by Ethiopian public health institute

Author's contributions

TS, IA and DS conceived the study. TS, IA, LB, BD and DT supervised the data collection. TS and DS did analysis and wrote the manuscript. All the authors commented and edited the draft and approved the final version.

Acknowledgment

We thank the study participants who participated into the survey and consented to give their blood for serum sample.

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