Article

Seroprevalence of SARS-CoV-2 infection among occupational groups from Bucaramanga Metropolitan Area, Colombia

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Abstract: The negative effect of COVID-19 pandemic has reach world economy due to absence from work for SARS-CoV-2 infection in workers, among other things. However, some economic areas are essential to society and people must continue working outside home, to support economic reactivation; their serological profile could be different from global population. Cross-sectional study. Workers from health, construction, public transportation, public force, bike delivery messengers, independent or informal commerce areas, and residents of Bucaramanga or its metropolitan area were invited to participate. All participants self-completed a virtual survey and a blood test was taken to assess IgG and IgM with ARC COV2 test. Seroprevalence was estimated considering a complex survey design, correcting for finite population effect and adjusting for test performance. 7.045 workers were enrolled; 59.9% were women, most were residents of Bucaramanga and working in health occupations. Global adjusted seroprevalence was 19.5% (IC95% 18.6 - 20.4), being higher for Girón [27.9% (CI95% 24.5 - 31.30]). Workers with multiple contact with people during working hours or using public transportation to go to work had higher frequency of seropositivity for SARS-CoV-2. Seroprevalence among workers living in these four municipalities from the Colombian northeast area is still low.

Keywords: Seroepidemiologic Studies; Prevalence; Coronavirus Infections; Occupational Exposure; Occupational Health

1. Introduction

The COVID-19 pandemic has direct effects not just as infection, illness and death in many individuals around the world but also on the economy; since early implementation of governmental measures of obligatory social isolation to flatten the curve, the decrease in work activities generated a serious economic shrinking respect to pre-pandemic state [1] in several countries. Some sectors have been closed to collapse (Car sales -92%, and restaurants sales ~95%) [2], including those in Latin America and the Caribbean. (3) For this region, the World Bank projects a fall of -7,2% (with growth of 2.8% in 2021) and CEPAL estimates a contraction of -9,1% in 2020 [4,5].

In Colombia, World Bank projected a fall of -4.9% and CEPAL forecast a contraction of -5.6% in 2020 of Colombian economy [5]; also, governmental measures affected 9.2 million workers directly and National Republic Bank estimated economic losses between 4.6 billion and 59 billion pesos per month [6], where services (accommodation and food,

real estate, administrative services, professional and technical activities, construction and commerce) was the most affected economic area. However, a group of workers had to be active throughout the pandemic because they are essential to society. Working outside home amid the COVID-19 pandemic is an unavoidable activity for some occupational groups who cannot work from their homes. Moreover, in developing countries this may be more necessary due to the high occurrence of informal work with precarious labor conditions. The informal economy includes workers employed by formal, registered firms on a casual, day-wage basis, as well as subsistence actors such as self-employed workers, and workers involved in informal enterprises [7].

In Colombia, the government decreed a nationwide lockdown in March 2020 and was allowing the economic reactivation of various companies, in accordance with the capacity to fulfill biosafety protocols. This restart had important milestones on June 1 and September 1, 2020, due to the large number of permitted economic activities.   In the case of Santander, a department located in the northeast of the country, until June it was evident that the population strictly complied with the confinement [8]. Then there was a very rapid increase in the number of cases until it reached its peak in August 2020 (Figure 1a). Knowing the proportion of people infected by SARS-CoV-2 allows us to learn the real burden of this condition, and to identify expositional factors associated with infection to support decision-making in public health. In this way, several seroprevalence studies have been carried out in the world, however important differences in their estimates are being found [9]; probably because of location, moment of epidemic curve, type of population, antibody assessment test, among others. Additionally, differences in exposure probability could be related with occupational groups or professions. However, seroprevalence in our region is unknown, especially among workers who have worked during the pandemic. Therefore, the aim of this study was to estimate the seroprevalence of SARS-CoV-2 infection among workers from different occupational groups in the Bucaramanga Metropolitan Area (Santander, Colombia), who have been active outside the home throughout the pandemic.

2. Materials and Methods

Design and population. An observational cross-sectional study with prospective data collection was developed in Bucaramanga Metropolitan Area (Santander, Colombia), consisting of other three municipalities (Floridablanca, Girón and Piedecuesta). This region is inhabited by 1,111,999 people according to the National Population and Housing Census carried out in 2018 [10]. Adults (> 18 years old) who were formally employed in any of the following occupational groups: health, construction, public transportation (bus, taxi drivers), public force (army, police, transit officers) or bike delivery messengers, were independent workers o were part of informal commerce (including shopkeepers in grocery stores), and were residents of Bucaramanga or its metropolitan area since August 2020 were invited to participate.

Sampling. For formal employment, a stratified sampling by occupational groups according to census from the Bucaramanga Commerce Chamber was carried out. All legally constituted companies within these groups were identified and those selected were invited to participate; if they accepted, the study information was sent and disclosed among employees for voluntary participation. For informal employment, a convenience sampling was done in public markers, grocery stores and neighborhoods with a higher proportion of confirmed COVID-19 cases. Recruitment was carried out between September 28th and December 24th of 2020.

Data collection and variables. All participants self-completed an online survey on socio-demographic data (age, marital status, education level, socioeconomic strata, address), occupational sector (health, public transportation, public force, public services, security, construction, food, education, grocery store tenants/ informal commerce, inde-

pendent worker, administrative/municipal services, cleaning, bike deliveries workers, or another), cigarette smoking status, medical history (presence of stroke, hypertension, acute myocardial infarction, dyslipidemias, diabetes mellitus, COPD/asthma, obesity, non-skin cancer, HIV/AIDS, autoimmune diseases), possible contact with people with suspicion or confirmed COVID-19 infection, presence of symptoms since march 2020 (cough, fever> 38°c, chills, fatigue, myalgia, shortness of breath, wheezing, chest pain, headache, odynophagia, dizziness, rhinorrhea, diarrhea, nausea or vomiting, hemoptysis, nasal congestion, anosmia), information about possible exposition to infection such as type of transportation used to go to work or to assist medical consultations, use of personal protection elements (gloves, conventional mask, N95 masks, specific clothes or shoes to go out on the street, glasses, face mask, hat or hair up), prevention activities (Bathing when entering the home, washing hands upon arrival at destination, washing hands every two hours, use antiseptic gel, keep distance of at least two meters from other people), quarantine (if symptoms or a positive PCR test), rapid tests previously performed, COVID-19 confirmed infection by PCR after the beginning of symptoms, hospitalization or ICU. Study data were collected and managed using REDCap electronic data capture tools hosted at Fundación Cardiovascular [11,12]. Electronic informed consent was obtained from all subjects involved in the study. This consent was available to be downloaded and saved by each participant.

Geolocation. Participants' addresses were collected in a parameterized way (type, number, suffix and cardinal direction of the main and secondary roads, license plate number, neighborhood, city, department and country). Then, the address was standardized with a road or intersection type for each participant according to the world composite geocoder in ArcGIS online. ArcGIS world geocoding service for Colombia offers level 2 or good quality, which refers to the degree of street-level address coverage in the country [13]. First, ArcGIS tools were used to convert the REDCap database to an ArcGIS geodatabase file; second, each attribute of the address, neighborhood, city, department, and country data were matched against the fields of ArcGIS world composite geocoder; thirdly, the batch geocoder was executed, which consisted in transforming the address data into point-like geographic coordinates on the map for each record of the data batch, establishing a real position of each participant on the geographic territory; and finally, a spatial database was generated where each record had a score between 0 and 100 (100 being the best accuracy) that indicated the degree of agreement with the address. For records with scores <100, a manual geolocation debugging was performed, verifying the location on the base cartography, maps in ArcGIS online and geographic information systems (Supplemental material, Figure S1 shows the flow of each of the stages for geolocation).

IgG and IgM measurement. A peripheral blood sample (~5 cc) by venipuncture in the forearm was obtained for every participant. The sample was transported from sampling site to the clinical laboratory of the Fundación Cardiovascular de Colombia to perform Immunoglobulin G (IgG) detection by chemiluminescence assay and Immunoglobulin M (IgM) by enzymatic fluorescence immunoassay. ARC COV2 test from Abbot® was used for immunoglobulin assessment. This test reports a qualitative result (positive/negative for each antibody). Positive results, either only IgG, IgM, or both, were reported to SISMUESTRAS (https://apps.ins.gov.co/sismuestras) from *Instituto Nacional de Salud* (INS), as a complementary measure for possible case identification, given the high underestimation found in our region and country [14]. Participants that had only IgM positive were immediately informed through email recorded in the virtual survey and were also reported to the Health and Safety at Work department in their companies (for formally employed workers) to assess the need to confirm a possible infection with PCR.

Statistical methods. Variables are reported as means with 95% CI and absolute and relative frequencies. Prevalence was estimated as the number of positive participants

(either for IgG, IgM, or both) for the numerator on the total number of participants, as the denominator. Additionally, seroprevalence is also presented according to only IgG positive, IgG and IgM positive, and only IgM positive (Table 1 and Table 2). The dataset was declared as survey (*svyset*), probability weights (*pweights*) were estimated by municipality as N/n, where N = number of people between 18 and 85 years old in the population and n = the number of participants in our sample and strata were defined according to occupational sector. Finite Population Correction (FPC) was also estimated using ((N-n)/(N-1))1/2 formula, where N was the number of people between 18 and 85 years old in the population and n was the number of participants in the sample. Primary Sampling Unit (PSU) were municipalities (Bucaramanga, Floridablanca, Girón and Piedecuesta). Additionally, prevalence was adjusted by test performance (Sensitivity 85.2%, Specificity 97.3%) [15] using the formula proposed by Tempos and Sian as adjusted prevalence = crude prevalence + specificity-1 / sensitivity + specificity − 1. (16) The effect of recruitment day (independent variable) on test results (outcome variable) was assessed through Poisson regression (*svy: poisson*) adjusting for municipalities, gender, occupational sector, and age. Statistical analysis was done in Stata 15.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Fundación Cardiovascular de Colombia (protocol code CEI-2020-01485, September 17th, 2020).

3. Results

7.045 workers were included in the study with a greater proportion of women, residents of Bucaramanga and health workers (Table 1). During the recruitment period, there was no evidence of a peak in the report of confirmed SARS-CoV-2 new cases or deaths in the four municipalities (Figure 1a and 1b).

Table 1. Sociodemographic variables of study participants according immunoglobulin type.[a]

Variable	All	Negative	IgG+ only	IgG/ IgM+	IgM+ only
n	7045	5738	677	434	196
Age, (years, n= 6629)*	37.4	37.2	35.1	39.5	34.3
	(36.3 – 38.4)	(36.6 – 37.8)	(33.9 – 36.3)	(38.3 – 40.7)	(32.6 – 36.1)
Sex					
Men	2821 (40.0)	2308 (40.3)	264 (38.6)	186 (43.1)	63 (31.5)
Women	4219 (59.9)	3426 (59.6)	412 (61.2)	248 (56.9)	133 (68.5)
Other	5 (0.1)	4 (0.1)	1 (0.1)	-	-
Municipality					
Bucaramanga	3347 (47.5)	2752 (48.8)	310 (45.7)	202 (46.4)	83 (42.8)
Floridablanca	2226 (31.6)	1836 (25.5)	201 (23.0)	123 (21.9)	66 (26.4)
Girón	628 (8.9)	466 (11.9)	87 (18.5)	56 (18.6)	19 (14.1)
Piedecuesta	774 (10.9)	633 (13.8)	69 (12.5)	46 (13.0)	26 (16.5)
Other	70 (0.9)	-	-	-	-
Socioeconomic status					
1 (lowest)	575 (8.2)	412 (7.4)	94 (13.9)	48 (10.3)	21 (10.5)
2	1563 (22.2)	1175 (20.7)	213 (31.2)	126 (29.1)	49 (24.9)
3	2442 (34.6)	1977 (35.2)	240 (36.4)	154 (36.6)	71 (37.5)
4	1712 (24.3)	1496 (25.6)	102 (14.6)	78 (17.8)	36 (18.1)
5	395 (5.6)	352 (5.4)	15 (1.9)	17 (3.5)	11 (4.9)
6 (higher)	320 (4.5)	296 (4.9)	8 (1.1)	9 (1.9)	7 (3.3)
Unknown	38 (0.5)	30 (0.5)	5 (0.7)	2 (0.4)	1 (0.5)
Occupational sector					
Health	3295 (46.8)	2.697 (47.2)	309 (45.6)	183 (43.1)	106 (55.1)
Public transportation	282 (4.0)	237 (4.1)	25 (3.7)	11 (2.7)	9 (4.3)
Public force (po-	148 (2.1)	114 (1.8)	17 (2.2)	15 (3.5)	2 (1.0)

lice/army)				
Public services	242 (3.4)	213 (3.7)	19 (2.9)	8 (1.7)	2 (1.0)
Security	114 (1.6)	91 (1.6)	10 (1.6)	6 (1.4)	7 (3.5)
Construction	440 (6.2)	343 (6.0)	59 (8.2)	33 (6.9)	5 (2.2)
Food	151 (2.1)	118 (2.0)	18 (2.4)	13 (2.9)	2 (1.3)
Education	136 (1.9)	120 (2.0)	7 (1.2)	5 (1.0)	4 (2.2)
Grocery store tenants / informal commerce	194 (2.7)	141 (2.4)	23 (3.4)	25 (5.7)	5 (2.5)
Independent worker	398 (5.6)	309 (5.1)	35 (5.2)	45 (10.5)	9 (3.8)
Administrative municipal services	1095 (15.5)	920 (15.9)	94 (13.8)	53 (12.2)	28 (14.1)
Cleaning	106 (1.5)	79 (1.5)	15 (2.3)	9 (2.0)	3 (1.4)
Bike delivery workers	13 (0.2)	9 (0.1)	1 (0.1)	3 (0.6)	-
Other	422 (6.0)	338 (6.0)	45 (6.3)	25 (5.2)	14 (7.2)

a. Percentages in parentheses

Figure 1. Reported SARS-CoV-2 daily confirmed cases and deaths for municipalities of the Bucaramanga Metropolitan Area
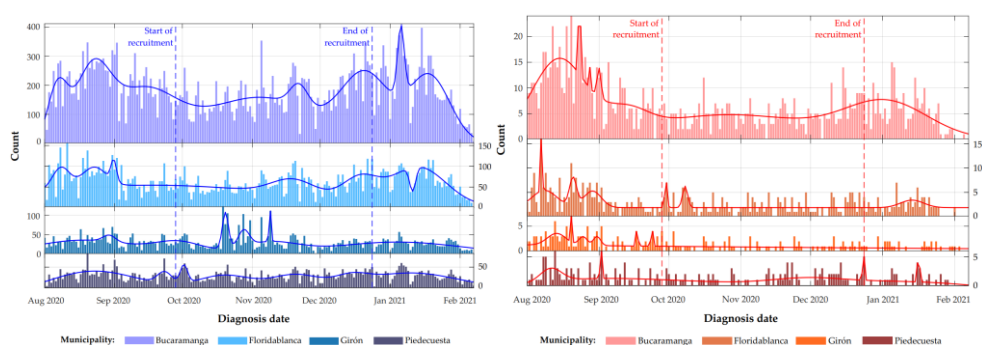
(**a**) Cases   (**b**) Deaths

Dash lines delimit the frame time in which recruitment was done (September 28th and December 24th of 2020). Data source: Colombia National Health Institute; https://www.ins.gov.co/Noticias/Paginas/coronavirus-casos.aspx.

3.1 Spatial characterization. The highest participation was concentrated in Bucaramanga, followed by Floridablanca, Piedecuesta and Girón (Figure 2a). Figure 2b shows the density map that identifies city areas with the highest number of participants located in urban area/km2 in each municipality; a higher concentration of participation is shown in Bucaramanga, specifically towards the east of the municipality, while in Girón participants were more dispersed.

Figure 2. Participant's Geolocation at Bucaramanga Metropolitan Area. (a) Spatial distribution of participants and density/km2 in urban areas for municipalities of Bucaramanga Metropolitan Area. (b) Participants density/km^2 for each municipality

(**a**) Spatial distribution

(**b**) Participants density/km²
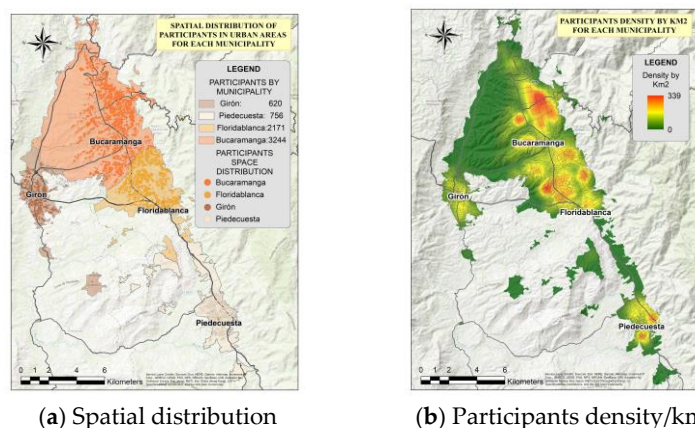
3.2 Clinical data. Most participants did not report active cigarette consumption and less than 20% had previous medical conditions (Table 2); the most frequent chronic disease was hypertension (10.0%) followed up by COPD/asthma (9.6%), dyslipidemia (6.0%), obesity (5.9%), autoimmune diseases (4.6%), diabetes mellitus (2.5%), non-skin cancer (1.9%), acute myocardial infarction (0.5%), stroke (0.3%) and HIV/AIDS (0.2%). On the other hand, 58.2% of participants reported having more than one chronic disease.

3.3 Exposure variables. The most used transportation to go to work was the own car (30.3%), followed by motorcycle (26.5%) and public transport (21.1%). The rest of the workers reported walking (10.2%), taxi (7.1%), bicycle (1.2%) or none (3.7%) to go to work. Almost half of the participants reported having contact with a person with suspected or confirmed COVID-19 infection. However presence of symptoms and hospitalization due to COVID-19 was low (Table 2); 91.7% reported using a face mask and only 9.5% used face shield as protection elements.

**Table 2.** Clinical and exposure to SARS-CoV-2 variables according to immunoglobulin type. [a]

Variable	All	Negative	IgG+ only	IgG/ IgM+	IgM+ only
n	7.045	5.738	677	434	196
Smoking					
Yes (Currently)	345 (4.9)	302 (5.3)	25 (3.8)	9 (1.9)	9 (4.3)
Yes (Past)	1421 (20.2)	1.177 (20.3)	110 (15.9)	96 (22.1)	38 (19.2)
Yes (passive)	419 (5.9)	341 (6.0)	35 (5.1)	31 (7.1)	12 (6.6)
No	4860 (69.0)	3.918 (68.2)	507 (75.0)	298 (68.6)	137 (69.7)
Medical conditions					
Yes	1333 (18.9)	1.105 (18.9)	110 (15.7)	83 (18.6)	35 (17.3)
No	5509 (78.2)	4.474 (78.2)	549 (81.3)	332 (77.2)	154 (79.2)
Do not know	203 (2.9)	159 (2.8)	18 (2.8)	19 (4.2)	7 (3.3)
Contact with people with suspected or confirmed COVID-19					
Yes	3153 (44.8)	2.525 (43.9)	314 (46.4)	223 (52.0)	91 (45.0)
No	2898 (41.1)	2.411 (41.9)	262 (38.4)	144 (32.9)	81 (42.5)
Do not know	994 (14.1)	802 (14.0)	101 (15.1)	67 (15.0)	24 (12.4)
Symptoms related to COVID-19 since March 2020					
Yes	1643 (23.3)	1.074 (18.7)	297 (44.4)	230 (54.0)	42 (21.5)
No	5041 (71.5)	4.375 (76.1)	344 (50.3)	176 (39.7)	146 (74.4)
Do not know	361 (5.1)	289 (5.1)	36 (5.1)	28 (6.1)	8 (3.9)
Due to beginning of symptoms, COVID-19 diagnosis was confirmed					
Yes	401 (5.7)	101 (9.6)	159 (53.9)	130 (55.9)	11 (27.5)
No	474 (6.7)	405 (38.2)	25 (8.3)	25 (11.8)	19 (4.6)
No PCR	694 (9.8)	516 (48.5)	101 (34.6)	68 (30.1)	9 (22.1)
Do not know	56 (0.8)	40 (3.5)	8 (3.0)	6 (2.1)	2 (4.3)
Not applicable	5420 (76.9)				
Due to beginning of symptoms, was hospitalized for COVID-19 symptoms					

|					
Yes	32 (0.4)	9 (0.6)	7 (2.4)	15 (5.7)	1 (1.3)
No	1846 (26.2)	1266 (99.1)	301 (97.1)	223 (93.5)	26 (98.6)
Do not know	4 (0.1)	2 (0.2)	-	2 (0.8)	-
Not applicable	5420 (76.9)				

      a.   Percentages in parentheses

      3.4 Seroprevalence. Overall corrected prevalence by study design was 18.8% (95% CI 17.5 - 20.2), and adjusted for test performance was 19.5% (95% CI 18.6 - 20.4). According to municipality, Girón had the greater adjusted seroprevalence [27.9% (95% CI 24.5 - 31.3), Piedecuesta 18.8% (95% CI 16.0 - 21.5), Bucaramanga 18.3% (95% CI 17.0 - 19.6), Floridablanca 17.9% (95% CI 16.4 - 19.5)] (Figure 3; Figure S2a and S2b). For occupational groups (Figure 4, table S1), those participants with multiple contact with other people during their working hours, such as motorcycle delivery workers, grocery store tenants and informal commerce workers, had a higher frequency of seropositivity for SARS-CoV-2. While seroprevalence was similar among age groups (Supplemental material, Table S1), smoking status and presence of medical conditions (Table 2), it was higher in workers that used bike [25.7% (95% CI 16.6 - 34.8)], motorcycle [24.0% (95% CI 22.1 - 25.9)] and public transportation [23.9% (95% CI 21.8 - 26.0)] than those using their own car [13.0% (95% CI 11.5 - 14.4)] or taxi [15.5% (95% CI 12.3 - 18.7)], to go to work.

Figure 3. Seroprevalence by municipalities
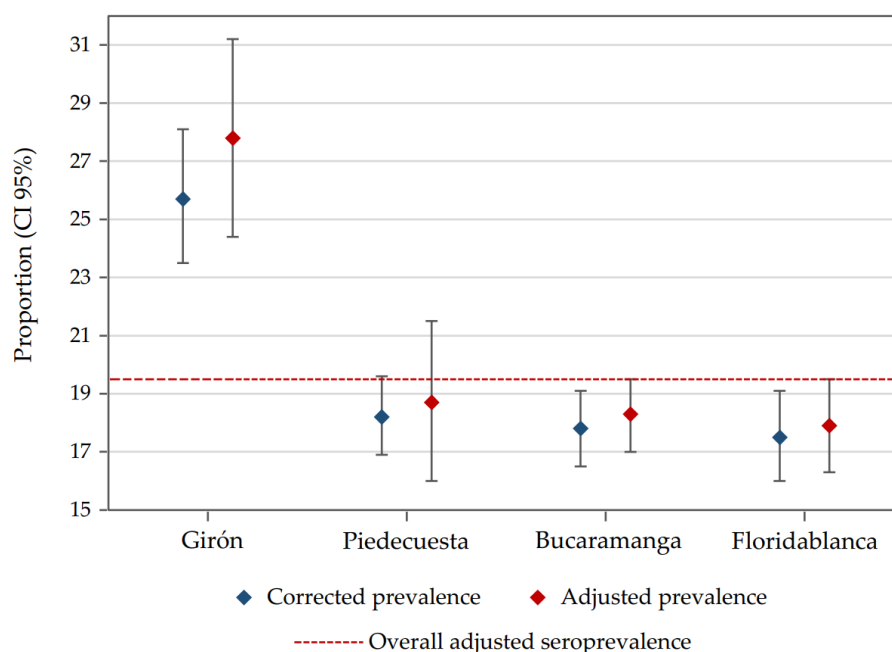
◆ Corrected prevalence   ◆ Adjusted prevalence

-------- Overall adjusted seroprevalence

      Dash line represents overall adjusted seroprevalence estimated in our study. This line is added for comparison purposes.

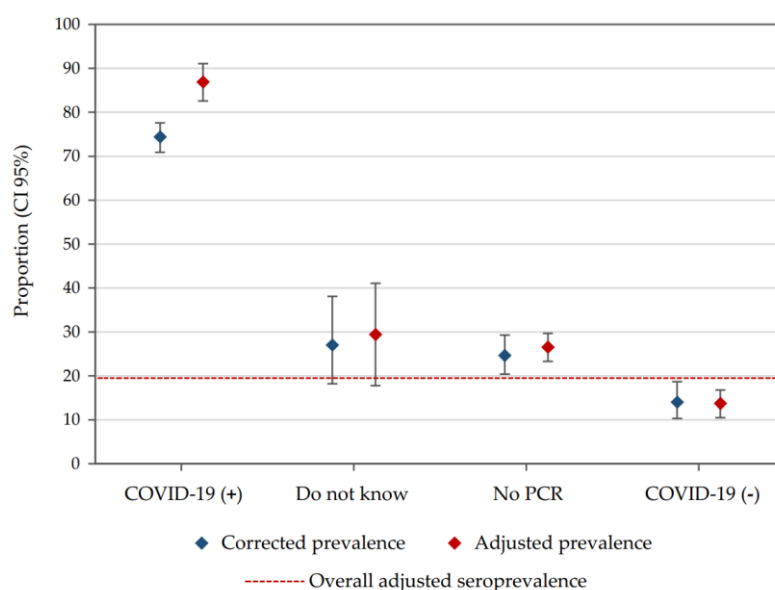**Figure 4. Seroprevalence according to occupational group**
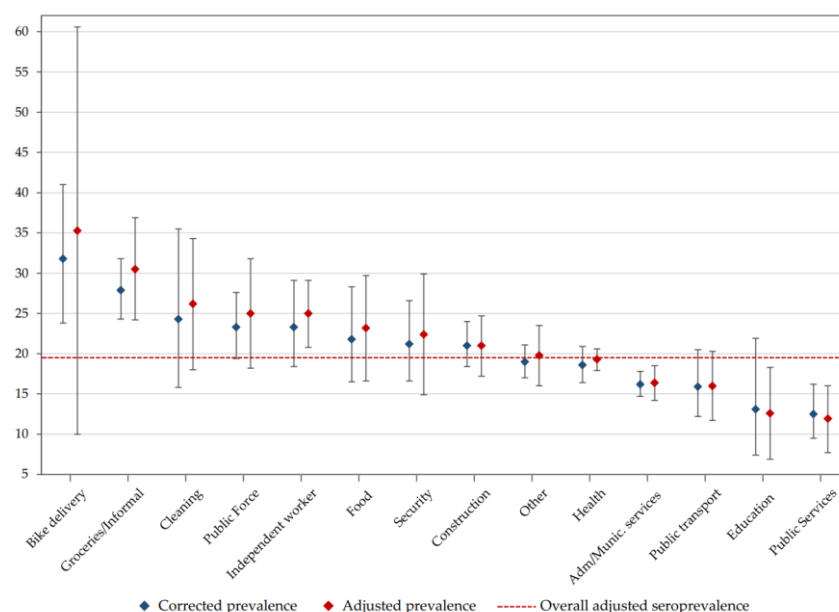
Dash line represents overall adjusted seroprevalence estimated in our study. This line is added for comparison purposes.

Participants that had symptoms related to COVID-19 since march 2020 presented an adjusted seroprevalence of 50.3% [(95% CI 47.9 – 52.7) vs 57.7% (95% CI 56.3 – 59.1) for those not having symptoms], and participants that had contact with a person with suspected or confirmed COVID-19 infection presented an adjusted seroprevalence of 49.9% [(95% CI 48.1 - 51.7) vs 41.8% (95% CI 40.1 - 43.5) of those not having contact].

On the other hand, for people with a previous confirmed diagnosis report of COVID-19, adjusted seroprevalence was 86.9% (95% CI 82.6 - 91.1) compared to 13.7% (95% CI 10.5 - 16.8) for those with a negative PCR (Figure 5). Given that our recruitment period was long, the effect of time on the probability of being seropositive was evaluated but it was not statistically significant, even when adjusting by municipality, occupational group, age and sex (Supplemental material, Table S2).

Figure 5. Seroprevalence according to self-reported COVID-19 previous diagnosis

Dash line represents overall adjusted seroprevalence estimated in our study. This line is added for comparison purposes.

4. Discussion

This study is the first one to investigate seroprevalence in different occupational groups in the Bucaramanga Metropolitan Area (Santander, Colombia), under the concept of "Super-spreaders" [17, 18] to refer to individuals who due to their work occupation are in contact with many people during their working hours [17] that could facilitate the spread of the infection. The results should be compared with caution given the transmission behavior of COVID-19 in Colombia was not homogeneous. The peaks that occurred were established at different times according to the severity of each department's restrictions, especially mobility and closure of the different economic sectors. Furthermore, there is no history of this type of analysis by occupational groups, except in health workers.

In a municipality survey on the seroprevalence of SARS-CoV-2, we analyzed over 7,000 blood samples for IgM and IgG antibody testing using currently available commercial assays. We found that, in three of four participating municipalities around 18% of people from different occupational sectors had evidence of SARS-CoV-2 infection (adjusted for population weighting and test performance). The seroprevalence was relatively lower in the group aged 60 to 69 years (16.1%). On the other hand, seroprevalence varied between occupational sectors, with estimates as high as 35.3% in bike delivery workers and 30.5% in grocery store tenants of informal economy and as low as 11.9% and 12.5% in the public services and education sector, respectively.

In Colombia, previous seroprevalence surveys focused on regions or municipalities where there were transmission hot spots in the community, such as Montería [19], and studies in all Colombian territory (Estudio País) have found high frequency as in Leticia (59%, 95% CI: 54-65) and Barranquilla (55%, 95% CI:51-61) meanwhile in other cities the frequency have been lower [Bogotá 30% (95% CI:27-33), Medellín 27% (95% CI:24-31) and Bucaramanga 32% (95% CI:29-36), unpublished data] [20]. Other surveys focused on high-risk populations, such as health workers, have reported so far seroprevalences between 22% (Medellín) and 55% (Villavicencio) [20]. Our estimate of general seroprevalence (19.8%) was lower than the estimates reported so far for other studies reported in Colombia and very close to those reported for other countries as Iran, 22.16 (95% CI:18.7-26.0) [21]. However, this difference could be related to the type of population included, given that in our study were included subjects only over 18 years of age that reside and work (occupational sectors) in previously mentioned municipalities and that in *Estudio Pais* only Bucaramanga was the city included while in our study the Metropolitan Area constituted by three other municipalities were evaluated.

Variations in seroprevalences for SARS-CoV-2 are very common, even in the same region or country. Rostami et al. [22] found a pooled seroprevalence for south America of 1.45 (95% CI: 0.95-1.94), including studies from Chile [10.78 (95% CI: 9.1–12.5)] and Brazil [0.96 (95% CI: 0.52–1.40)] conducted between March and May 2020 [0.222% (95% CI: 0.107–0.408%) for Rio de Janeiro [9] where new cases per day where starting to rise. If we compared the estimate of general seroprevalence among the participating population in our study, it was higher than the estimates of seroprevalence in countries such as Spain (5.01, 95% CI: 4.83-5.18) or the United States (4.41%, 95% CI: 3.03-5.79). Therefore, it is more likely that the difference observed is related to the epidemic conditions of each territory and the restrictions approved in the sanitary regulations applied in each region than to the test's characteristics [23].

Besides differences in location or type of population assessed in every study reported so far, variations in seroprevalence could be also related with timing and test used to assessed immunoglobulins. In Bucaramanga, the first COVID-19 peak began at the end of July with highest number of cases by mid-August with a second wave after mid-November (~300 cases/day, when national estimates where done). However, no significant association has been reported between the incidence of COVID-19 cases and seroprevalence, such as reported by some authors [9]. On the other hand, the estimates of

lower seroprevalence in our study compared to National Seroprevalence study could be related in part to the characteristics of the test used, given that it was an in-house test [24,25] and our study used a commercial test.

This study has strengths. Sample size recruited is the largest one for a small non-capital city in Colombia. Also, the estimation of seroprevalence was done in an adjusted way considering complex design analysis and test performance. Also, this study has some limitations. Even though we did a wide invitation to several companies in Bucaramanga Metropolitan Area, the most interested ones who agreed to participate in the survey were those providing health services. Other companies such as taxi drivers or bike messengers had low motivation to participate despite the probability of high SARS-CoV-2 exposure. Additionally, our recruitment time frame was long for a seroprevalence study, however and according to the National Health Institute the daily report of new cases and deaths was constant in the four municipalities in this period; also, we studied the effect of time (recruitment day) on test results, and this was not statistically significant.

5. Conclusions

Seroprevalence for SARS-CoV-2 in workers living at Bucaramanga Metropolitan Area remains low; even below national estimates for our region. Also, given the variation in time and type of population assessed, these results only reflect estimates for occupational groups in the four municipalities included. These results reinforce the variation in frequency of seropositivity for the infection according to location, exposure and moment of the epidemic curve which makes a challenge to find the true infection burden. Seroprevalence surveillance should be done periodically to better understand infection behavior and even to estimate seroconversion frequency and its related factors.

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