Original research

SARS-CoV-2 surveillance strategy in essential workers of the Madrid City Council during the first epidemic wave in Spain, March–July 2020

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ABSTRACT

Objectives To study prevalence of infection in essential workers of Madrid City Council by occupation, related characteristics, use of protective devices, risk perception, and main concerns about COVID-19 during lockdown.

Methods A total of 30 231 workers were PCR tested for SARS-CoV-2 infection. Information was collected on COVID-19-related symptoms, risk factors, preventive equipment, and risk perception. The crude prevalence was calculated for infection, use of protective devices, perceived risk and main concerns. Additionally, adjusted prevalence and prevalence ratios (PR) were estimated for these variables using logistic regression models with age, gender, occupation, epidemiological week and laboratory as confounding factors.

Results Overall prevalence of infection was 3.2% (95% CI 3.0% to 3.4%), being higher among policemen (4.4%) and bus drivers (4.2%), but lower among emergency healthcare personnel, firefighters, food market workers and burial services (<2%). Lower excess risk was observed in workers reporting occupational contact with COVID-19 cases only (PR=1.42; 95% CI 1.18 to 1.71) compared with household exposure only (PR=2.75; 95% CI 2.32 to 3.25). Infection was more frequent in symptomatic workers (PR=1.28; 95% CI 1.11 to 1.48), although 42% of detected infections were asymptomatic. Use of facial masks (78.7%) and disinfectants (86.3%) was common and associated with lower infection prevalence (PR_{masks}=0.68; 95% CI 0.58 to 0.79; $PR_{disinfectants}$=0.75; 95% CI 0.61 to 0.91). Over 50% of workers felt being at high risk of infection and worried about infecting others, yet only 2% considered quitting their work.

Conclusions This surveillance system allowed for detecting and isolating SARS-CoV-2 cases among essential workers, identifying characteristics related to infection and use of protective devices, and revealing specific needs for work-safety information and psychological support.

KEY MESSAGES

WHAT IS ALREADY KNOWN ON THIS TOPIC?

⇒ During a strict lockdown, essential activities must be maintained, increasing the risk of infection in workers performing these jobs.
⇒ While health professionals have been extensively studied, little is known about other essential worker collectives, such as policemen, bus drivers, firefighters and burial services.

WHAT ARE THE NEW FINDINGS?

⇒ Bus drivers and policemen presented the highest prevalence of infection. On the contrary, workers in burial and emergency health services showed lower risk of infection, despite being in contact with patients with COVID-19 and/or corpses. This was likely due to the regular use of protective devices, since the continued use of facial masks, gloves and disinfectants significantly reduced the risk of infection.
⇒ While most of these workers accepted the risks associated with their job, they showed concern about the possibility of being infected and felt a lack of control over it.

HOW MIGHT THIS IMPACT ON POLICY OR CLINICAL PRACTICE IN THE FORESEEABLE FUTURE?

⇒ The risk of infection is elevated in essential personnel outside the realms of healthcare and home assistance. Detecting infections among these collectives is also important to protect the population they serve.
⇒ Essential workers need both information and protective measures in order to decrease their infection risk. In times of a pandemic, they may also require psychological assistance to cope with stress and concerns.

INTRODUCTION

Since December 2019, the world is fighting an epidemic caused by a novel coronavirus, SARS-CoV-2, that started in China and rapidly spread worldwide, becoming a pandemic.[1] In Europe, Spain has been, and remains, one of the most severely affected countries by the ongoing COVID-19 pandemic.[2]

During the first epidemic wave, the region of Madrid—with a 6.7 million population—was heavily struck, with 75 842 confirmed cases, 43 726 hospitalisations and 15 160 deaths registered

between 25 February and 10 July 2020. In this period, the cumulative incidence reached 1124 cases per 100 000 people, peaking on 26 March, when 3378 new COVID-19 cases were diagnosed (incidence rate of 50 per 100 000 persons per day).[3]

On 14 March, the Spanish Government declared a state of emergency and imposed a severe lockdown, maintaining only essential services and activities. Many public employees of the Madrid City Council were considered essential workers and occupational health protection services determined that monitoring SARS-CoV-2 infection among them was important to guarantee the proper functioning of essential services and protect both these workers and the people they served. Therefore, the Madrid City Council decided to organise a specific surveillance programme using PCR tests to screen and perform early diagnosis of SARS-CoV-2 infection among these collectives. The programme started on 25 March with approximately 600 tests weekly and gradually increased its capacity up to >2000 weekly tests in May 2020. The programme objectives were twofold: protecting the workers' health and preventing further transmission among their colleagues and relatives as well as the population they serve. This specifically designed surveillance system provided a unique perspective of the infection risk among specific professional groups, such as local policemen, public bus drivers, or firefighters, during the lockdown and the de-escalation period in Madrid.[4] This study presents the prevalence data drawn from this programme up to 11 July 2020.

MATERIAL AND METHODS

Design and participants

Cross-sectional study reporting the results of a special surveillance system implemented by the Madrid City Council to detect SARS-CoV-2 infections in municipal workers who performed their occupational activity inperson during severe lockdown (essential workers). At that time, PCR testing was restricted to severe hospitalised cases and healthcare workers, whereas people with symptoms had to isolate themselves without being PCR tested. This system was implemented with the support of a research unit for animal testing that reorganised its services, later expanding to a second laboratory to enable offering PCR testing to all essential workers. Every worker accepted to be tested despite it not being mandatory, since most people were anxious to know whether they were infected or not, particularly those not confined due to work duty. Thus, policemen, bus drivers, firefighters and burial services workers were fully tested. In terms of other collectives, only face-to-face staff were invited to be tested and occupational health services prioritised those they considered at higher risk, namely workers in close contact with COVID-19 cases, who tested positive in a previous PCR, or with symptoms compatible with COVID-19 before returning to work following confinement. Occupational health services communicated the test results and, if needed, adopted specific prevention measures. In all cases, workers were responsible for informing about their symptoms and previous PRC testing results. At the end of April, the surveillance was extended to workers returning to their posts after weeks of telecommuting. These non-essential employees were considered as the reference group in subsequent analyses.

RT-PCR detection

Nasopharyngeal swabs were collected in a viral transport medium (Deltalab S.L., Spain) by trained healthcare staff. Samples were packed immediately in cooled biosafety containers and sent for diagnosis to two laboratories using different methods given the workload. The first laboratory (INIA-CISA) analysed 10 514 samples (34.8%) using an in-house procedure based on recommended PCR testing.[5 6] The second laboratory (Synlab) analysed the remaining 19 670 swabs employing a commercial PCR kit (Shanghai Fosun Long March Medical Science Co.). Results were available within 24 hours following sample receipt, which helped to accelerate public health control measures.

Epidemiological questionnaire

Participants were asked to complete a questionnaire on their smartphones before knowing their PCR test results. The questionnaire included sociodemographic variables, COVID-19 related symptoms (fever, runny nose, severe tiredness, overall discomfort, sore throat, dry and persistent cough, shortness of breath, headache, unusual back pain, muscle pain, anosmia or ageusia, nausea or vomiting, and diarrhoea); contact with suspected/confirmed COVID-19 cases; emergency room visits/hospitalisations; previous PCR testing; and use of protective material. Self-perceived risk was also examined via an adapted questionnaire from a previous study assessing exposure, risk perception, and altruistic acceptance of risk on hospital employees in China during the SARS epidemic[7] (see online supplemental material).

Statistical analysis

Descriptive statistics were expressed by their percentages and means, with the corresponding 95% confidence intervals (95% CI). To control for confounding variables, the prevalence of infection was standardised to the overall distribution of age, gender, occupation, epidemiological week, which was included as a categorical variable, and laboratory of analysis using a logistic regression model. This was performed using the command Margins of the STATA statistical package (V.16), which computes the predicted prevalence for each category, averaging or otherwise integrating over the other covariates included in the model.[8] Associations between demographic, occupational and epidemiological variables and infection were assessed via prevalence ratios (PR). Use of protective material and different indicators of risk perception were evaluated similarly and adjusted by the same potential confounders. Differences in the use of protective material and risk perception among these occupational groups were also assessed using PR. Individuals with missing values were excluded. Missing values were nearly inexistent in the reporting of symptoms, very low in the reporting of fears and feelings (2.5%–4.2% of participants, except for 11% for the question "being willing to accept the risks of the work"), and 8%–11% in the reporting of methods of protection.

RESULTS

The programme asked 30 231 workers to participate, all of which were PCR tested. Of them, 67.9% were men and 3 out of 4 (73.6%) were 40–59 years old (table 1). Average age was 48.3 years (men: 47.8; women: 49.2).

The PCR results were positive in 951 workers (table 1), with an overall adjusted prevalence of infection of 3.2% (95% CI 3.0% to 3.4%) for the whole period, which was slightly higher in men than in women (3.3% and 2.8%, respectively) and increased slightly with age (from 3.0% in workers under 40 years old to 3.8% in those over 60 years old).

Similarly to the incidence in the region, the prevalence of active infection declined every week, from an adjusted value of 34.3% in the third week of March (22–28) to 0.3% in the last week (5–11 July) (figure 1).

Table 1 Prevalence of SARS-CoV-2 infection among essential workers by gender, age and occupation

	Number of participants	Crude prevalence % (95% CI)	Adjusted prevalence* % (95% CI)	Adjusted prevalence ratio (95% CI)
Overall	30231	3.2 (3.0 to 3.4)	3.2 (3.0 to 3.4)	
Gender				
Men	20521	3.5 (3.2 to 3.7)	3.3 (3.1 to 3.6)	Ref
Women	9710	2.4 (2.1 to 2.8)	2.8 (2.5 to 3.2)	0.86 (0.73 to 1.01)
Age, years				
<40	5020	2.8 (2.4 to 3.3)	3.0 (2.5 to 3.5)	Ref
40–49	10504	3.2 (2.8 to 3.5)	3.1 (2.8 to 3.4)	1.03 (0.85 to 1.25)
50–59	11420	3.3 (3.0 to 3.7)	3.2 (2.9 to 3.5)	1.09 (0.90 to 1.31)
≥60	2840	3.2 (2.7 to 4.0)	3.8 (3.0 to 4.5)	1.26 (0.98 to 1.63)
Type of work				
Telecommuting	10415	1.9 (1.7 to 2.2)	3.3 (2.6 to 3.9)	Ref
Policemen	6554	4.6 (4.1 to 5.1)	4.4 (3.6 to 5.2)	1.35 (0.97 to 1.88)
Bus drivers	5339	3.2 (2.7 to 3.7)	4.2 (3.4 to 5.1)	1.29 (1.03 to 1.61)
Cleaning services	2210	4.2 (3.4 to 5.1)	3.1 (2.4 to 3.9)	0.96 (0.72 to 1.27)
Firefighters	1403	3.5 (2.7 to 4.6)	1.6 (1.1 to 2.2)	0.49 (0.32 to 0.76)
Emergency healthcare services	910	3.9 (2.8 to 5.3)	1.5 (1.0 to 2.1)	0.46 (0.29 to 0.73)
Burial services	443	3.6 (2.2 to 5.8)	1.9 (0.9 to 2.8)	0.57 (0.31 to 1.02)
Central Market workers	350	2.9 (1.5 to 5.2)	1.7 (0.6 to 2.7)	0.51 (0.27 to 0.96)
Public health services	1400	2.7 (2.0 to 3.7)	2.5 (1.7 to 3.3)	0.75 (0.50 to 1.13)
Social services	1207	3.6 (2.7 to 4.8)	2.1 (1.4 to 2.8)	0.64 (0.44 to 0.92)

*Adjusted by age, gender, occupation, epidemiological week, and laboratory.

The adjusted prevalence of active infection also varied depending on the occupational group, being higher among policemen (4.4%) and bus drivers (4.2%), and lower for emergency healthcare service workers (1.5%), firefighters (1.6%), workers in Madrid Central wholesale market (1.7%), and burial services (1.9%). Workers who had been telecommuting, which were considered the reference category, showed an intermediate prevalence (3.3%), implying that the PR was >1 only for certain essential jobs (table 1).

Characteristics associated with SARS-CoV-2 infection

A total of 23762 participants (78.6%) answered the epidemiological questionnaire. People who completed it showed a greater

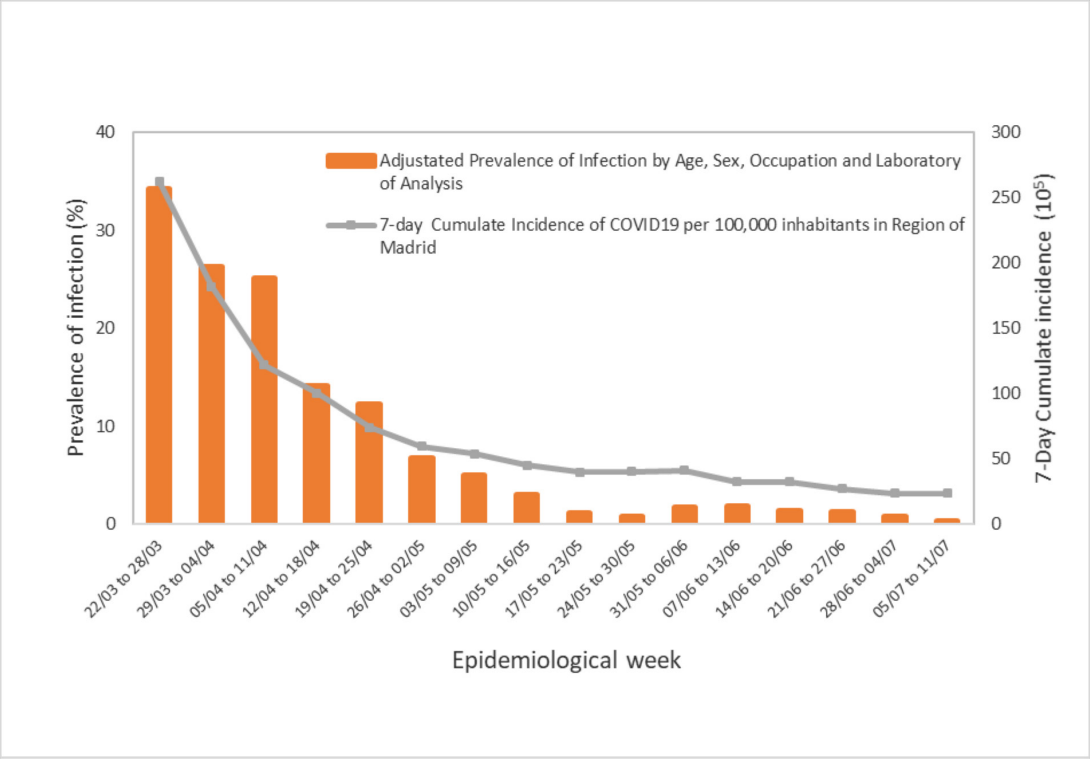

Figure 1 Prevalence of SARS-CoV-2 infection and 7-day cumulative incidence of COVID-19 by epidemiological week in the Community of Madrid.

infection prevalence than non-responders (3.4% vs 2.2%, respectively). Participation rate was over 70% independently of their occupation, age, or gender group. Collaboration was particularly high among workers in Madrid Central wholesale market (85.7%).

Table 2 displays prevalence estimates according to self-reported COVID-19 exposure and symptoms. One in four workers declared having had contact with COVID-19 cases: 14.2% from a close contact only at work, 10.4% from only household exposure, and 2.1% under both settings. The prevalence of PCR positive was greater among workers reporting only occupational contact (PR=1.42; 95% CI 1.18 to 1.71) versus teleworkers. However, workers exposed to household cases only showed twofold risk compared with occupational exposure only (PR=1.94; 95% CI 1.58 to 2.38).

In terms of healthcare assistance, 760 workers (3.4%) reported having attended emergency services because of COVID-19 symptoms and 0.9% were hospitalised, with a prevalence of positive PCR of 11.2% and 13.9%, respectively (table 2).

In terms of COVID-19 related symptoms, 49.9% of responders stated feeling one or more symptoms over the previous 2 weeks and 25.3% were symptomatic at the moment of answering the questionnaire. Subjects with symptoms during the last 14 days had a higher prevalence of infection (PR=1.11; 95% CI 0.97 to 1.28), especially those who were symptomatic at the moment of testing (PR=1.28; 95% CI 1.11 to 1.48). The symptoms mostly related to a positive PCR test result, whether during the previous 2 weeks or at recruitment, were anosmia/ageusia (PR=4.82 and 4.87, respectively), fever (PR=1.57 and 2.71, respectively), general discomfort (PR=1.66 and 1.97, respectively), and cough (PR=1.48 and 1.88, respectively). On the other hand, asymptomatic cases represented 42.1% of all infections.

Table 3 shows the outcomes of the use of protective equipment. Facial masks were always or often used by 78.7% of included workers, gloves were used by 63.4%, and disinfectant products by 86.3% of them. The prevalence of infection was lower among those using these items (PR_{masks}=0.68, 95% CI 0.58 to 0.79; $PR_{disinfectants}$=0.75, 95% CI 0.61 to 0.91; PR_{gloves}=0.75, 95% CI 0.64 to 0.87). Use of other types of protective equipment was lower and did not significantly associate with the prevalence of SARS-CoV-2 infection. As expected, the profile of use of protective material differed among occupations, being more common in emergency health workers (online supplemental table S1).

Risk perception

Table 4 summarises the results on risk perception related to COVID-19 among the included municipal workers. Three in four accepted the risks associated with their job, even if almost 60% considered that their risk of infection was high. Half of the participants were worried about infecting other people, and one in four confessed that their family was also worried about the possibility of being infected by them (26.2%). Feeling a lack of control over their risk of infection and worrying about falling sick was also common (18.0% and 22.8%, respectively). Almost one in three participants (31.5%) declared being stressed, particularly in burial and social services, with adjusted PRs of stress >2 (PR=2.62 and PR=2.46, respectively) compared with teleworkers, followed by emergency healthcare workers (PR=1.59) and bus drivers (PR=1.37). Only 2% declared having considered quitting their job, a proportion that also was highest among burial services (PR=2.15) and social services (PR=2.30).

DISCUSSION

This study was conducted during the lockdown in Spain and presents information on the prevalence of SARS-CoV-2 infection and related factors among essential workers in Madrid, a city heavily affected by the COVID-19 pandemic at that time. These results add valuable information about infection prevalence in several essential-work groups that have not received much attention during this pandemic. Although the infection prevalence in the included collectives was high in the first weeks (>30%), it showed a pronounced declining trend parallel to the local epidemic wave (figure 1), resulting in a relatively low overall prevalence for the study period (3.2%). Bus drivers and policemen were the staff most affected, while firefighters, emergency healthcare services, Madrid Central wholesale market workers, and social services personnel showed lower infection prevalence.

These results derive from a special surveillance programme launched by the Madrid City Council to monitor and protect essential workers that was implemented in a moment of severe shortage of PCR tests, which was very well received by the participating staff. This initiative allowed for studying the impact the new virus had on these groups and for obtaining relevant information on the infection prevalence. Additionally, the type of protective measures and frequency of use among the different collectives were evaluated, as well as their correlation with the infection prevalence. Finally, this study also assessed the perception of fears and work-related dangers due to COVID-19 in these workers.

The risk of infection clearly increased with occupational exposure. These results are in line with the Spanish National seroprevalence study (ENE-COVID), where essential workers also showed higher seroprevalence (6.3% police and firefighters, 5.8% transport workers, 7.9% social services, 10% healthcare professionals) than the general population (4.6%).[9] These findings support the need for implementing preventive protection measures for these collectives, including isolation of cases and close contacts, provision of protective equipment, and updated information about preventive measures. Nevertheless, their excess risk was lower than the twofold increase resulting from household contact, likely due to the use of protective measures at work. Along these lines, studies on SARS-CoV-2 infection also suggest that infections among healthcare workers can be related to viral transmission in the community.[10 11]

From the beginning of the pandemic, certain occupational sectors were over-represented among COVID-19 cases. In Singapore, the first country reporting cases outside China, 17 of the first 25 locally transmitted cases (68%) occurred among occupationally exposed workers in tourism, retail, healthcare, construction and transport sectors.[12] Also, a study in six different countries showed that approximately 75% of work-related cases occurred among personnel in healthcare (22%), freight and passenger transport (18%), services and sales (18%), professional and domestic cleaning (9%) and public safety (7%).[13] Occupational outbreaks have also been described, (ie, bus transportation in China[14] or abattoirs and slaughterhouses in North America and Europe[15]). In Qatar, the overall prevalence in workers was 29.4%, with the highest rate among construction and related jobs (40.0%) and the retail and wholesale trade sectors (40.0%).[16] Specific occupations may have suffered more severe cases. Mutambudzi *et al* evaluated a large population-based sample in England and reported a higher risk of severe COVID-19 among essential workers, including social care and transport services, highlighting the need for policies for

Table 2 Prevalence of SARS-CoV-2 infection by close contacts and symptoms

	Number of participants	Crude prevalence % (95% CI)	Adjusted prevalence* % (95% CI)	Prevalence ratio (95% CI)
Overall	23 762	3.4 (3.2 to 3.7)	3.4 (3.2 to 3.6)	
Contact with a COVID case				
No contact	17 402	2.3 (2.1 to 2.5)	2.6 (2.3 to 2.8)	Ref
Occupational contact	3372	5.0 (4.3 to 5.8)	3.6 (3.1 to 4.2)	1.42 (1.18 to 1.71)
Household contact	2483	7.9 (6.9 to 9.0)	7.0 (6.1 to 8.0)	2.75 (2.32 to 3.25)
Both	505	9.9 (7.6 to 12.8)	7.3 (5.4 to 9.3)	2.87 (2.15 to 3.83)
Symptoms (previous 2 weeks)				
No	11 897	2.9 (2.6 to 3.2)	3.2 (2.9 to 3.6)	Ref
Yes	11 865	4.0 (3.6 to 4.3)	3.6 (3.3 to 3.9)	1.11 (0.97 to 1.28)
Symptoms at recruitment				
No	17 755	3.1 (2.9 to 3.4)	3.2 (2.9 to 3.4)	Ref
Yes	6007	4.3 (3.9 to 4.9)	4.1 (3.6 to 4.5)	1.28 (1.11 to 1.48)
Shortness of breath				
No	22 320	3.3 (3.0 to 3.5)	3.4 (3.1 to 3.6R)	Ref
Yes, previous 2 weeks	919	6.1 (4.7 to 7.8)	4.2 (3.1 to 5.3)	1.26 (0.96 to 1.66)
Yes, at recruitment	523	5.2 (3.6 to 7.4)	4.1 (2.6 to 5.6)	1.22 (0.83 to 1.77)
Fever (>37.7°C)				
No	23 322	3.2 (3.0 to 3.5)	3.3 (3.1 to 3.6)	Ref
Yes, previous 2 weeks	417	11.8 (9.0 to 15.2)	5.2 (3.7 to 6.8)	1.57 (1.15 to 2.13)
Yes, at recruitment	23	21.7 (9.4 to 42.8)	9.1 (0.9 to 17.2)	2.71 (1.10 to 6.73)
Low fever				
No	22 225	3.2 (2.9 to 3.4)	3.3 (3.1 to 3.5)	Ref
Yes, previous 2 weeks	1325	6.8 (5.6 to 8.3)	4.2 (3.3 to 5.0)	1.26 (1.01 to 1.58)
Yes, at recruitment	212	9.4 (6.2 to 14.2)	7.0 (4.0 to 10.0)	2.12 (1.38 to 3.26)
Dry and persistent cough				
No	22 142	3.1 (2.9 to 3.3)	3.2 (3.0 to 3.5)	Ref
Yes, previous 2 weeks	954	8.3 (6.7 to 10.2)	4.8 (3.7 to 5.8)	1.48 (1.16 to 1.88)
Yes, at recruitment	666	7.7 (5.9 to 9.9)	6.0 (4.4 to 7.6)	1.88 (1.43 to 2.48)
Runny nose				
No	18 877	3.4 (3.1 to 3.6)	3.4 (3.2 to 3.7)	Ref
Yes, previous 2 weeks	2411	3.8 (3.1 to 4.7)	3.3 (2.6 to 4.0)	0.96 (0.78 to 1.19)
Yes, at recruitment	2474	3.5 (2.8 to 4.3)	3.5 (2.8 to 4.2)	1.03 (0.83 to 1.28)
Sore throat				
No	21 225	3.3 (3.0 to 3.5)	3.4 (3.2 to 3.7)	Ref
Yes, previous 2 weeks	1806	4.4 (3.6 to 5.5)	3.0 (2.4 to 3.7)	0.88 (0.70 to 1.11)
Yes, at recruitment	731	5.3 (3.9 to 7.2)	4.5 (3.1 to 5.9)	1.32 (0.96 to 1.80)
Headache				
No	18 135	3.2 (3.0 to 3.5)	3.4 (3.1 to 3.7)	Ref
Yes, previous 2 weeks	4482	3.6 (3.1 to 4.2)	3.1 (2.6 to 3.5)	0.9 (0.76 to 1.07)
Yes, at recruitment	1145	5.6 (4.4 to 7.1)	5.1 (3.9 to 6.3)	1.49 (1.16 to 1.92)
Anosmia/ageusia				
No	22 735	2.7 (2.5 to 2.9)	2.8 (2.5 to 3.0)	Ref
Yes, previous 2 weeks	607	20.3 (17.3 to 23.7)	13.3 (11.0 to 15.6)	4.82 (3.98 to 5.84)
Yes, at recruitment	420	18.6 (15.1 to 22.6)	13.5 (10.6 to 16.3)	4.87 (3.88 to 6.12)
Severe tiredness				
No	19 124	3.0 (2.8 to 3.3)	3.2 (2.9 to 3.4)	Ref
Yes, previous 2 weeks	2559	5.0 (4.3 to 6.0)	3.9 (3.2 to 4.6)	1.23 (1.01 to 1.48)
Yes, at recruitment	2079	5.0 (4.1 to 6.0)	4.7 (3.8 to 5.6)	1.49 (1.21 to 1.82)
General discomfort				
No	21 827	3.0 (2.8 to 3.2)	3.1 (2.9 to 3.4)	Ref
Yes, previous 2 weeks	1393	8.3 (6.9 to 9.8)	5.2 (4.2 to 6.2)	1.66 (1.35 to 2.03)
Yes, at recruitment	542	7.9 (5.9 to 10.5)	6.2 (4.4 to 8.0)	1.97 (1.46 to 2.66)
Unusual back pain				
No	21 737	3.2 (3.0 to 3.4)	3.3 (3.0 to 3.5)	Ref
Yes, previous 2 weeks	1047	7.6 (6.1 to 9.3)	5.1 (4.0 to 6.2)	1.55 (1.23 to 1.95)
Yes, at recruitment	978	4.2 (3.1 to 5.6)	3.8 (2.6 to 4.9)	1.14 (0.84 to 1.55)

continued

Table 2 continued

	Number of participants	Crude prevalence % (95% CI)	Adjusted prevalence* % (95% CI)	Prevalence ratio (95% CI)
Muscle pain				
No	20 734	3.1 (2.9 to 3.3)	3.2 (3.0 to 3.5)	Ref
Yes, previous 2 weeks	1622	7.0 (5.9 to 8.4)	4.8 (3.9 to 5.7)	1.5 (1.23 to 1.83)
Yes, at recruitment	1406	4.2 (3.3 to 5.4)	4.1 (3.1 to 5.1)	1.26 (0.98 to 1.64)
Vomiting, nausea				
No	23 162	3.4 (3.2 to 3.6)	3.4 (3.2 to 3.6)	Ref
Yes, previous 2 weeks	484	4.1 (2.7 to 6.3)	3.1 (1.7 to 4.4)	0.9 (0.58 to 1.40)
Yes, at recruitment	116	5.2 (2.3 to 11.0)	5.5 (1.3 to 9.7)	1.61 (0.75 to 3.44)
Diarrhoea				
No	21 748	3.3 (3.1 to 3.6)	3.4 (3.2 to 3.7)	Ref
Yes, previous 2 weeks	1654	4.2 (3.4 to 5.3)	3.3 (2.5 to 4.0)	0.96 (0.75 to 1.22)
Yes, at recruitment	360	5.3 (3.4 to 8.1)	4.6 (2.6 to 6.6)	1.36 (0.87 to 2.11)
Emergency room visits				
No	22 804	3.1 (2.9 to 3.4)	3.2 (3.0 to 3.4)	Ref
Yes	811	11.2 (9.2 to 13.6)	8.6 (6.9 to 10.4)	2.72 (2.21 to 3.36)
Hospitalisation				
No	23 454	3.3 (3.1 to 3.6)	3.3 (3.1 to 3.6)	Ref
Yes	223	13.9 (10.0 to 19.1)	12.2 (8.3 to 16.1)	3.66 (2.64 to 5.08)

*Adjusted by age, gender, occupation, epidemiological week, and laboratory.

protecting and supporting these groups.[17] Moreover, a mortality excess by COVID-19 was described in England and Wales among social care workers, home caregivers, construction workers, cleaners, road transport drivers or security staff.[18] The infection rate in healthcare professionals ranged from 3% in a group of asymptomatic workers in a UK teaching hospital[19] up to 38% of tested workers at a large hospital in Madrid in March 2020, at the peak of the first epidemic wave.[10] The latter figure is close to the adjusted prevalence of 34.3% observed in the first week of this study (22–28 March).

Essential workers showed extensive use of protective equipment, which were available to these collectives despite their scarcity during the first weeks of the pandemic. The infection prevalence was lower among workers who always used these materials, reaching statistical significance for protective masks, disinfectant products and gloves. Their use could explain the lower prevalence of infection among firefighters, emergency healthcare workers and Central Market workers. Burial staff use these types of equipment regularly and also showed very low prevalence rates despite the high risk associated with handling

Table 3 Prevalence of SARS-CoV-2 infection according to the use of protective equipment

	Number of participants	Crude prevalence % (95% CI)	Adjusted prevalence* % (95% CI)	Prevalence ratio (95% CI)
Overall	23 762	3.4 (3.2 to 3.7)	3.4 (3.2 to 3.6)	
Mask				
Never/rarely	4628	4.8 (4.2 to 5.5)	4.6 (4.0 to 5.2)	Ref
Often/always	17 108	3.1 (2.8 to 3.3)	3.1 (2.9 to 3.4)	0.68 (0.58 to 0.79)
Disinfectant products				
Never/rarely	2997	3.9 (3.3 to 4.7)	4.4 (3.6 to 5.2)	Ref
Often/always	18 946	3.4 (3.1 to 3.6)	3.3 (3.1 to 3.6)	0.75 (0.61 to 0.91)
Gloves				
Never/rarely	7968	3.5 (3.1 to 3.9)	4.1 (3.7 to 4.6)	Ref
Often/always	13 832	3.4 (3.1 to 3.7)	3.1 (2.8 to 3.4)	0.75 (0.64 to 0.87)
Disposable gowns				
Never/rarely	20 535	3.4 (3.2 to 3.7)	3.5 (3.2 to 3.7)	Ref
Often/always	966	3.4 (2.4 to 4.8)	2.9 (1.9 to 3.9)	0.83 (0.58 to 1.20)
Face shield				
Never/rarely	20 317	3.5 (3.2 to 3.7)	3.5 (3.2 to 3.7)	Ref
Often/always	1413	3.6 (2.8 to 4.7)	3.3 (2.3 to 4.3)	0.95 (0.69 to 1.29)
Goggles				
Never/rarely	19 012	3.5 (3.2 to 3.7)	3.5 (3.3 to 3.8)	Ref
Often/always	2797	3.5 (2.9 to 4.2)	3.0 (2.4 to 3.7)	0.86 (0.68 to 1.09)
Protection suit				
Never/rarely	20 407	3.4 (3.2 to 3.7)	3.5 (3.2 to 3.7)	Ref
Often/always	1383	3.9 (3.0 to 5.1)	3.1 (2.1 to 4.1)	0.90 (0.65 to 1.25)

*Adjusted by age, gender, occupation, epidemiological week, and laboratory.

Table 4 Risk perception and prevalence ratios by occupation

	Global prevalence	Adjusted prevalence ratio*† (95% CI)								
	n/N (%)	Policemen	Bus drivers	Cleaning services	Firefighters	Emergency healthcare services	Burial services	Central Market workers	Public health services	Social services
Being afraid of falling ill	4139/23 305 (18.0)	0.84 (17.22 to 19.45)	1.12 (1.02 to 1.22)	1.08 (0.96 to 1.22)	0.70 (0.56 to 0.88)	1.23 (1.00 to 1.51)	1.28 (1.00 to 1.63)	0.91 (0.69 to 1.20)	0.84 (0.72 to 0.99)	0.95 (0.81 to 1.10)
Feeling like I had little control over whether I could get infected or not	5237/22 955 (22.8)	0.90 (0.79 to 1.02)	1.25 (1.16 to 1.34)	1.07 (0.96 to 1.19)	0.78 (0.65 to 0.93)	0.79 (0.65 to 0.97)	1.36 (1.11 to 1.65)	0.88 (0.69 to 1.12)	0.99 (0.86 to 1.13)	1.06 (0.93 to 1.20)
Thinking that I had little chance of survival if I got infected	1431/22 812 (6.3)	0.62 (0.46 to 0.83)	1.08 (0.93 to 1.26)	1.03 (0.83 to 1.29)	0.40 (0.24 to 0.67)	1.02 (0.67 to 1.57)	1.21 (0.76 to 1.92)	1.44 (0.96 to 2.16)	1.00 (0.76 to 1.31)	1.10 (0.84 to 1.44)
Being worried about spreading the virus to someone else	11 567/23 141 (50.0)	0.93 (0.87 to 0.99)	1.21 (1.17 to 1.26)	1.21 (1.15 to 1.28)	0.81 (0.73 to 0.90)	1.03 (0.93 to 1.14)	1.27 (1.14 to 1.41)	0.99 (0.87 to 1.12)	0.94 (0.87 to 1.02)	0.89 (0.82 to 0.97)
Thinking that my family is worried that I might infect them	6020/23 022 (26.1)	1.07 (0.96 to 1.20)	1.57 (1.46 to 1.68)	1.61 (1.47 to 1.76)	0.87 (0.74 to 1.02)	1.39 (1.19 to 1.62)	1.61 (1.35 to 1.92)	1.18 (0.96 to 1.44)	1.06 (0.93 to 1.21)	0.99 (0.86 to 1.14)
Believing that my job has high risk of infection	13 598/23 185 (58.7)	1.52 (1.44 to 1.60)	1.43 (1.38 to 1.48)	1.40 (1.33 to 1.47)	1.38 (1.28 to 1.49)	1.62 (1.51 to 1.74)	1.74 (1.62 to 1.87)	1.25 (1.13 to 1.39)	0.97 (0.89 to 1.05)	1.34 (1.26 to 1.42)
Feeling a lot of stress at work	7220/22 906 (31.6)	1.22 (1.10 to 1.35)	1.37 (1.29 to 1.47)	1.11 (1.01 to 1.22)	1.14 (0.98 to 1.31)	1.59 (1.39 to 1.82)	2.62 (2.35 to 2.91)	1.18 (0.98 to 1.41)	0.99 (0.87 to 1.12)	2.46 (2.28 to 2.64)
Feeling that I am performing tasks that I am not prepared for	1201/22 826 (5.3)	1.12 (0.86 to 1.48)	1.05 (0.86 to 1.27)	0.81 (0.61 to 1.07)	0.75 (0.50 to 1.12)	0.65 (0.41 to 1.05)	1.78 (1.16 to 2.72)	0.71 (0.39 to 1.30)	0.94 (0.68 to 1.31)	2.37 (1.87 to 3.01)
Thinking about quitting my job because of the coronavirus	468/23 154 (2.0)	1.07 (0.66 to 1.71)	0.81 (0.61 to 1.09)	0.71 (0.45 to 1.11)	1.02 (0.49 to 2.13)	1.47 (0.68 to 3.14)	2.15 (0.99 to 4.65)	0.46 (0.14 to 1.46)	1.26 (0.77 to 2.07)	2.30 (1.54 to 3.42)
Feeling that people avoid my family because of my work	283/23 092 (1.2)	1.78 (0.95 to 3.37)	2.22 (1.49 to 3.30)	2.07 (1.17 to 3.64)	0.97 (0.40 to 2.34)	3.10 (1.46 to 6.59)	3.68 (1.56 to 8.68)	2.41 (0.93 to 6.27)	0.88 (0.37 to 2.11)	1.74 (0.84 to 3.64)
Being willing to accept the risks that my job implies	16125/21 364 (75.5)	1.21 (1.17 to 1.25)	1.13 (1.10 to 1.16)	1.17 (1.13 to 1.21)	1.20 (1.14 to 1.27)	1.18 (1.11 to 1.25)	1.15 (1.07 to 1.24)	1.02 (0.94 to 1.10)	1.10 (1.05 to 1.15)	1.00 (0.95 to 1.05)

*Adjusted by age, gender, occupation, epidemiological week, and laboratory.
†Based on telecommuting participants as the reference group.

infected material in a period of intense overwork. In a specific study on essential workers, Alishaq *et al* concluded that the risk of becoming infected appeared to be driven by community spread rather than occupational exposure.[20]

Asymptomatic cases hinder pandemic control and prevention of transmission in work environments. The implemented surveillance system allowed for identifying and isolating these cases, reducing the risk of occupational exposure and transmission. The proportion of workers with a positive PCR who did not experience any symptom over the two previous weeks was 42.1%, which is substantially lower than that reported among retail workers in Massachusetts (76%),[21] similar to nurses in USA and UK (56% and 57%, respectively),[22] and higher than the 20% reported in an Italian hospital.[23] On the other hand, the ENE-COVID study estimated 28.5% of asymptomatic infections in the general population in Spain.[9] The estimate in the present study was substantially higher, although it included infected workers detected before the onset of symptoms (presymptomatic cases).

It is worth noting that the evolution of the infection prevalence among essential workers paralleled that of COVID-19 cases in the region. In fact, the information occupational health services collected could be a valuable and complementary source of information to estimate the intensity of SARS-CoV-2 circulating in the community. Since this surveillance system was implemented end of March 2020, when the first pandemic wave was declining, the infection prevalence during the growth stage of the wave was not included, when high-risk collectives could have been particularly affected. However, the questionnaire asked about previous hospitalisations due to SARS-CoV-2. Based on self-reported information, this study estimated a prevalence of 942 COVID-19 hospitalisations per 100 000 people, substantially higher than the overall reported figure in Madrid (653 per 100 000),[3] which corroborates the excess risk in that population and justifies the implementation of this programme.

Essential workers were fully aware of being at higher risk of infection and their main concern was spreading the virus to someone else (50%), a proportion very similar to the figure reported among Dutch sociosanitary workers.[24] In the present study, this concern was particularly important among bus drivers, cleaning services and burial services workers. The latter sector together with social services experienced the highest perception of being at risk. The high mortality derived from the pandemic surpassed the capacity of burial services, resulting in a strong emotional impact on these workers. On the other hand, the only social services considered essential during confinement were care facilities for people in vulnerable situations, such as the homeless, a population whose problems severely increased with the pandemic. Providing care for them implied a high level of involvement, entailing psychological impact on the workers. These findings are along the lines of other studies[25] and highlight the need for psychosocial support for these collectives.

The implementation of this surveillance system allowed for obtaining information on all essential workers in the Madrid City Council. PCR results, gender and workplace were recorded for all participants, while the remaining variables were collected through a questionnaire that was self-completed before knowing the PCR result to avoid biases. The overall high response rate (78.6%) was substantially superior to those in other studies with similar approaches.[24] This study was possible because the surveillance system gathered data specifically aimed at examining and protecting the workers' health. Other authors have stressed the need for this kind of systematic surveillance.[26] One strength of this study is the reporting of occupational prevalence adjusted by age, gender, and risk of exposure due to the concurrent levels of virus circulation in the community (ie, week of testing). Also, occupational health services prioritised PCR testing based on their evaluation of risk, so the tested collectives varied each week (see online supplemental table S2); at the same time, since the programme commenced at the peak of the pandemic, the strict lockdown drastically reduced the circulation of the virus, resulting in a declining risk of exposure over time. The calculated adjusted PRs allowed for accounting for these confounding factors. On the other hand, the excess risk of infection in essential workers may be partially affected by their socioeconomic conditions.[17] Such factors, which could not be taken into account in this study, are important to design specific policies for occupational safety.

The potential occurrence of false-positive and false-negative results in SARS-CoV-2 detection is a common concern, although the second case will cause the worst consequences for health and disease control.[27–30] In this study, the high sensitivity of the selected PCR protocol[6 31] was fundamental to ensure the detection of infected personnel even at asymptomatic or mildly symptomatic stages.

This study confirms that active-testing strategies in high-risk groups, like the included sample, are feasible and affordable, compared with the burden derived from pandemic control.[31] It also corroborates the importance of incorporating systematic data collection into public-health intervention programmes, which can often be achieved at a minimal cost, as shown in this study, increasing the value of these interventions for epidemiological surveillance

purposes. In our opinion, this was one of the strengths of this work, as this aspect is frequently hampered by the urgent need to implement responses, limitation of resources and difficulties for researchers to cooperate with decision-makers.

The present study addressed the impact of the COVID-19 pandemic on different groups of essential public workers in a large city during confinement. These results provided information not only about the impact of the pandemic but also about risk perception and concerns felt by the workers, important aspects that are seldom taken into account. Additionally, at a moment when isolation and quarantines were dictated based on symptoms exclusively, the programme allowed for detecting asymptomatic infections and applied the protocol established by public health authorities to the newly identified COVID-19 cases and close contacts, which probably affected the prevalence of infection among these collectives and the people they served, although estimating the magnitude of the effect is complex. Nevertheless, the early detection of infected personnel helped to reduce the risk of exposure to the virus during the worst stage of the epidemic in Madrid, while protecting the health of the workers as well as their colleagues and relatives.

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MA was responsible for supervising the collection and transport of laboratory samples. MDR and MdLF were responsible for collecting questionnaire data. MJF, RR and AA were responsible for the study operation and logistics. MM-C, CML-D, BP-G and MP wrote the first draft of the manuscript. All authors contributed to data interpretation, critically reviewed the manuscript, approved the final version and agreed to be accountable for the work.

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