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

Mercedes Martinez-Cortés, Carmen Maria León-Domínguez, Jovita Fernandez-Pinero, Mercedes Rodriguez, Mercedes Almonacid, Maria José Ferrarí, Rosario Romero, Alfonso Antona, M. Dolores Rivas, Miguel de La Fuente, Beatriz Pérez-Gómez, Marina Pollán

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<sub>masks</sub>=0.68; 95% CI 0.58 to 0.79; PR<sub>disinfectants</sub>=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.

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. In Europe, Spain has been, and remains, one of the most severely affected countries by the ongoing COVID-19 pandemic.

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

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 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.
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 in person 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 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.

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.5 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).

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 (see online supplemental material).
Workplace

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...
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 (PRmask = 0.68, 95% CI 0.58 to 0.79; PRdisinfectant = 0.75, 95% CI 0.61 to 0.91; PRglove = 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%). 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.

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. 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%). Occupational outbreaks have also been described, (ie, bus transportation in China or abattoirs and slaughterhouses in North America and Europe). 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%). 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...
| Symptoms (previous 2 weeks) | Number of participants | Crude prevalence % (95% CI) | Adjusted prevalence* % (95% CI) | Prevalence ratio (95% CI) |
|-----------------------------|------------------------|-----------------------------|---------------------------------|--------------------------|
| No contact                  | 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 contact                  | 17,755                 | 3.1 (2.9 to 3.4)            | 3.2 (2.9 to 3.4)                | Ref                      |
| Yes                         | 6,007                  | 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 contact                  | 22,320                 | 3.3 (3.0 to 3.5)            | 3.4 (3.1 to 3.6)                | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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 contact                  | 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)      |

*Adjusted for contact with a COVID case and symptoms at recruitment.
Workplace

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)        | 1.61 (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. 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. The infection rate in healthcare professionals ranged from 3% in a group of asymptomatic workers in a UK teaching hospital up to 38% of tested workers at a large hospital in Madrid in March 2020, at the peak of the first epidemic wave. 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 4  Risk perception and prevalence ratios by occupation

| Global prevalence | Policemen | Bus drivers | Cleaning services | Firefighters | Emergency healthcare services | Burial services | Central Market workers | Public health services | Social services |
|-------------------|-----------|-------------|-------------------|--------------|-------------------------------|----------------|------------------------|-----------------------|-----------------|
| n/N (%)           |           |             |                   |              |                               |                |                        |                       |                 |
| Feeling afraid of falling ill | 4139/23 305 (18.0) | 0.84 (0.79 to 1.02) | 1.08 (0.96 to 1.19) | 0.78 (0.65 to 0.93) | 1.23 (1.00 to 1.51) | 0.91 (0.89 to 1.03) | 0.84 (0.82 to 0.87) | 0.95 (0.91 to 0.99) | 0.95 (0.91 to 1.01) |
| Feeling like I had little control over whether I could get infected or not | 5237/23 955 (22.8) | 1.25 (1.16 to 1.34) | 1.07 (0.96 to 1.19) | 1.36 (1.11 to 1.65) | 1.28 (1.00 to 1.63) | 0.85 (0.83 to 0.87) | 0.99 (0.96 to 1.03) | 1.06 (0.93 to 1.20) | 1.05 (0.93 to 1.20) |
| Thinking that I had little chance of survival if I got infected | 1431/22 812 (6.3) | 1.12 (1.02 to 1.22) | 1.23 (1.10 to 1.36) | 1.08 (0.96 to 1.22) | 1.12 (1.02 to 1.22) | 0.84 (0.82 to 0.87) | 0.99 (0.96 to 1.03) | 1.00 (0.96 to 1.14) | 1.03 (0.96 to 1.13) |
| Being worried about spreading the virus to someone else | 11 567/23 141 (50.0) | 1.21 (1.17 to 1.26) | 1.26 (1.20 to 1.32) | 1.22 (1.16 to 1.28) | 1.21 (1.16 to 1.26) | 0.84 (0.82 to 0.87) | 0.99 (0.96 to 1.03) | 0.89 (0.82 to 0.97) | 1.05 (0.93 to 1.20) |
| Thinking that my family is worried that I might infect them | 60 200/23 022 (28.1) | 1.15 (1.07 to 1.25) | 1.26 (1.20 to 1.32) | 1.21 (1.15 to 1.28) | 1.21 (1.17 to 1.26) | 0.84 (0.82 to 0.87) | 0.99 (0.96 to 1.03) | 1.06 (0.93 to 1.20) | 0.92 (0.86 to 0.97) |
| Believing that my job has high risk of infection | 13 598/23 185 (58.7) | 1.45 (1.38 to 1.52) | 1.38 (1.32 to 1.44) | 1.38 (1.33 to 1.44) | 1.40 (1.34 to 1.46) | 0.90 (0.88 to 0.92) | 0.99 (0.96 to 1.03) | 1.34 (1.26 to 1.42) | 1.24 (1.16 to 1.32) |
| Feeling a lot of stress at work | 72 200/22 906 (31.6) | 1.11 (1.06 to 1.17) | 1.11 (1.06 to 1.17) | 1.14 (1.09 to 1.18) | 1.14 (1.09 to 1.18) | 0.84 (0.82 to 0.87) | 0.98 (0.95 to 1.01) | 1.26 (1.18 to 1.34) | 1.30 (1.23 to 1.37) |
| Feeling that I am performing tasks that I am not prepared for | 12 011/22 826 (5.3) | 1.19 (1.09 to 1.30) | 1.20 (1.12 to 1.28) | 1.19 (1.13 to 1.24) | 1.19 (1.13 to 1.24) | 0.91 (0.89 to 0.94) | 0.99 (0.96 to 1.03) | 2.46 (2.30 to 2.64) | 1.21 (1.16 to 1.27) |
| Thinking about quitting my job because of the coronavirus | 468/22 154 (2.0) | 1.08 (0.96 to 1.17) | 1.10 (1.04 to 1.15) | 1.05 (0.98 to 1.12) | 1.09 (1.03 to 1.15) | 0.84 (0.82 to 0.87) | 0.97 (0.94 to 1.01) | 2.37 (2.21 to 2.54) | 2.30 (2.14 to 2.48) |
| Feeling that people avoid my family because of my work | 283/23 092 (1.2) | 1.12 (1.09 to 1.15) | 1.12 (1.09 to 1.15) | 1.14 (1.10 to 1.18) | 1.14 (1.10 to 1.18) | 0.84 (0.82 to 0.87) | 0.95 (0.92 to 0.98) | 1.74 (1.59 to 1.90) | 1.85 (1.70 to 1.99) |
| Being willing to accept the risks that my job implies | 16 125/23 364 (75.5) | 1.17 (1.10 to 1.25) | 1.17 (1.10 to 1.25) | 1.20 (1.13 to 1.27) | 1.20 (1.13 to 1.27) | 0.84 (0.82 to 0.87) | 0.94 (0.91 to 0.97) | 1.00 (0.95 to 1.05) | 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.24 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 sanitary 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 studies25 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 protocol31 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.

Acknowledgements Antonio Prieto for promoting and supporting the project from the “Working Group for the Surveillance and Early Detection of COVID-19 infection in workers of the Madrid City Council”; Christine Schwarz and Bèlg Peñalver for their help with the database; Pablo Fernandez-Navarro and Mario Gonzalez for their support with the electronic questionnaires; Maribel Vargas for her collaboration from Occupational Health Services; Maria Barrado for her administrative support; Irene Rodriguez-Newey and “Gellentinos Translation” for reviewing the text. This study is the result of the efforts of many professionals and the trust of 30 231 workers who accepted to participate.

Contributors MM-C, CML-D, BP-G and MP were responsible for the conception and design of the study. MM-C is the executive coordinator of the project and led the relationship with the Occupational Health Services of the Madrid City Council. BP-G and CML-D were in charge of statistical analyses and table and figure design. JF-P was responsible for PCR testing, laboratory procedures and quality control processes. MR was in charge of institutional issues and communication of results.
MA was responsible for supervising the collection and transport of laboratory samples. MDR and MdIF 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.

**Funding** This study was funded by the Madrid City Council.

**Disclaimer** The funders were involved in the study logistics but had no role in the study design or in the collection, analysis, interpretation of data, or the decision to submit the article for publication. Grant number: not applicable.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** The study protocol was approved by the Ethics Committee of the Instituto de Salud Carlos III (ISCIII) and was registered with Ref: CEI PI 89_2020-v3. All participants provided written informed consent.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

This article is made freely available for use in accordance with BMJ’s website terms and conditions for the duration of the covid-19 pandemic or until otherwise determined by BMJ. You may use, download and print the article for any lawful, non-commercial purpose (including text and data mining) provided that all copyright notices and trade marks are retained.

**ORCID iDs**
Mercedes Martínez-Cortés http://orcid.org/0000-0002-5644-3957
Beatriz Pérez-Gómez http://orcid.org/0000-0002-4299-8214
Marina Pollán http://orcid.org/0000-0002-4328-1565

**REFERENCES**
1. World Health Organisation. Coronavirus diseases 2019. situation reports. Available: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
2. European Centre for DiseasePrevention and Control. Covid-19 situation update worldwide. Available: https://www.ecdc.europa.eu/en/geographical-distribution-2019-nccov-cases
3. Informe de situación COV-19. Comunidad de Madrid. Available: https://www.comunidad.madrid/sites/default/files/doc/sanidad/202010/cam_covid19.pdf
4. Working group for the surveillance and control of COVID-19 in Spain. Members of the Working group for the surveillance and control of COVID-19 in Spain. The first wave of the COVID-19 pandemic in Spain: characterisation of cases and risk factors for severe outcomes, as at 27 April 2020. Euro Surveill 2020;25.
5. Cormon VM, Eckerle I, Bleicher T, et al. Detection of a novel human coronavirus by real-time reverse-transcription polymerase chain reaction. Euro Surveill 2012;17. doi:10.2807/ese.17.39.20285-en. [Epub ahead of print: 27 Sep 2012].
6. Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, GA, USA. Available: https://www.cdc.gov/coronavirus/2019-noveltc/no-panel-primer-probes.html
7. Wu F, Fang Y, Guan Z, et al. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. Can J Psychiatry 2009;54:302–11.
8. Greenland S. Model-based estimation of relative risks and other epidemiologic measures in studies of common outcomes and in case-control studies. Am J Epidemiol 2004;160:301–5.
9. Pollan M, Perez-Gomez B, Pastor-Barriuso R, et al. Prevalence of SARS-CoV-2 in Spain (ENCECOVID): a nationwide, population-based seroepidemiological study. Lancet 2020;396:535–44.
10. Folgueira MD, Munoz-Ruiperez C, Alonso-Lopez MA. SARS-CoV-2 infection in health care workers in a large public hospital in Madrid, Spain, during March 2020. medRxiv 2020.
11. Hunter E, Price DA, Murphy E, et al. First experience of COVID-19 screening of healthcare workers in England. Lancet 2020;395:e77–8.
12. Koh D. Occupational risks for COVID-19 infection. Occup Med 2020;70:3–5.
13. Lan F-Y, Wei C-F, Hsu Y-T, et al. Work-related COVID-19 transmission in six Asian countries/areas: a follow-up study. PLoS One 2020;15:e0233588.
14. Shen Y, Li C, Dong H, et al. Community outbreak investigation of SARS-CoV-2 transmission among bus riders in eastern China. JAMA Intern Med 2020;180:1665–71.
15. Kromhout H. Learning from a global pandemic. Occup Environ Med 2020;77:587–8.
16. Al-Kuwari MG, Al-Nuaimi AA, Abdulmajied L, et al. COVID-19 infection across workplace settings in Qatar: a comparison of COVID-19 positivity rates of screened workers from March 1st until July 31st, 2020. J Occup Med Toxicol 2021;16:21.
17. Mutambudzi M, Niedzwiedz C, Macdonald EB, et al. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. Occup Environ Med 2020. doi:10.1136/oemed-2020-106731. [Epub ahead of print: 09 Dec 2020].
18. Coronavirus (COVID-19) related deaths by occupation, England and Wales: deaths registered up to and including 20 April 2020. Available: https://www.ons.gov.uk/rele
19. Caló F, Russo A, Camaioni C, et al. Burden, risk assessment, surveillance and management of SARS-CoV-2 infection in health workers: a scoring review. Infect Dis Poverty 2020;9:139.
20. Alishaq M, Jeremiñenko A, Nafty-Hegs H, et al. SARS-CoV-2 infection in mortuary and cemetery workers. Int J Infect Dis 2021;105:621–625.
21. Lan F-Y, Suhamil C, Kales SN, et al. Association between SARS-CoV-2 infection, exposure risk and mental health among a cohort of essential retail workers in the USA. Occup Environ Med 2021;78:237–43.
22. Rivett L, Siddhar S, Sparks D, et al. Screening of healthcare workers for SARS-CoV-2 highlights the role of asymptomatic carriage in COVID-19 transmission. Elife 2020;9. doi:10.7554/eLife.58728. [Epub ahead of print: 11 05 2020].
23. Lombardi A, Corsondi N, Carugno M, et al. Characteristics of 1573 healthcare workers who underwent nasopharyngeal swab testing for SARS-CoV-2 in Milan, Lombardy, Italy. Clin Microbiol Infect 2020;26:1413.e9–13. doi:10.1016/j.cmi.2020.06.013.
24. Nabe-Nielsen K, Nilsson CJ, Juul-Madsen M, et al. COVID-19 risk management at the workplace, fear of infection and fear of transmission of infection among frontline employees. Occup Environ Med 2021;78:248–54. doi:10.1136/oemed-2020-106831.
25. Muñoz-Moreno R, Chaves-Montero A, Morilla-Luchena A, et al. COVID-19 and social services in Spain. PLoS One 2020;15:e0241538.
26. De Matteis S. COVID-19: are not all workers “essential”? Occup Environ Med 2021;70:10727-2. doi:10.1136/oemed-2020-107272.
27. Avelx-House DB, Lavinia R, Raillery M, et al. The estimation of diagnostic accuracy of tests for COVID-19: a scoping review. J Infect 2020;81:681–97.
28. Carani L, Drena BS, Ambrogi P, et al. Time length of negativization and cycle threshold values in 182 healthcare workers with Covid-19 in Milan, Italy: an observational cohort study. Int J Environ Res Public Health 2020;17. doi:10.3390/ ijerp17155313. [Epub ahead of print: 23 07 2020].
29. West CP, Montori VM, Sampathkumar P. COVID-19 testing: the threat of false-negative results. Mayo Clin Proc 2020;95:1127–9.
30. Xiao AT, Tong YX, Zhang S. False negative of RT-PCR and prolonged nucleic acid conversion in COVID-19: rather than recurrence. J Med Virol 2020;92:1755–6.
31. Campbell JR, Uppal A, Oxlad E, et al. Active testing of groups at increased risk of acquiring SARS-CoV-2 in Canada: costs and human resource needs. CMAJ 2020;192:E1146–55. 10.1136/oemed-2021-107654