BMJ Open

COVID-19 among the inhabitants of the slums in the city of Buenos Aires: a population-based study

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To cite: Macchia A, Ferrante D, Battistella G, *et al*. COVID-19 among the inhabitants of the slums in the city of Buenos Aires: a population-based study. *BMJ Open* 2021;**11**:e044592. doi:10.1136/bmjopen-2020-044592

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-044592).

Received 07 September 2020
Revised 14 November 2020
Accepted 09 December 2020

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ABSTRACT

Objective To summarise the unfolding of the COVID-19 epidemic among slum dwellers and different social strata in the city of Buenos Aires during the first 20 weeks after the first reported case.

Design Observational study using a time-series analysis. Natural experiment in a big city.

Setting Population of the city of Buenos Aires and the integrated health reporting system records of positive RT-PCR for COVID-19 tests.

Participants Records from the Argentine Integrated Health Reporting System for all persons with suspected and RT-PCR-confirmed diagnosis of COVID-19 between 31 January and 14 July 2020.

Outcomes To estimate the effects of living in a slum on the standardised incidence rate of COVID-19, corrected Poisson regression models were used. Additionally, the impact of socioeconomic status was performed using an ecological analysis at the community level.

Results A total of 114 052 people were tested for symptoms related with COVID-19. Of these, 39 039 (34.2%) were RT-PCR positive. The incidence rates for COVID-19 towards the end of the 20th week were 160 (155 to 165) per 100 000 people among the inhabitants who did not reside in the slums (n=2 841 997) and 708 (674 to 642) among slums dwellers (n=233 749). Compared with the better-off socioeconomic quintile (1.00), there was a linear gradient on incidence rates: 1.36 (1.25 to 1.46), 1.61 (1.49 to 1.74), 1.86 (1.72 to 2.01), 2.94 (2.74 to 3.16) from Q2 to Q5, respectively. Slum dwellers were associated with an incidence rate of 14.3 (13.4 to 15.4).

Conclusions The distribution of the epidemic is socially conditioned. Slum dwellers are at a much higher risk than the rest of the community. Slum dwellers should not be considered just another risk category but an entirely different reality that requires policies tailored to their needs.

Strengths and limitations of this study

- The main strength of the study is that it included all the reported cases of COVID-19 (confirmed by RT-PCR) in the city of Buenos Aires.
- The demographic databases used in this study allow the ecological characterisation of the characteristics of the different neighbourhoods of the city and the slums.
- As it happens in administrative and case-report databases, there may have been classification errors. This could have been the case of people whose postal address did not allow an appropriate characterisation. These data were corrected manually.
- The ecological characterisation of the city's neighbourhoods can be considered reductionist, as it does not incorporate individual data but rather population aggregates. However, the attributes of the neighbourhoods are usually strong indicators of health outcomes.
- The results show internal consistency in terms of increasing gradients between indicators of deprivation and incidence rates.

INTRODUCTION

The COVID-19 pandemic is a major public health challenge. However, this threat is not evenly distributed neither among nations nor within countries.[1–6] Argentina in general, and the city of Buenos Aires in particular, constitute a model case study of the inequities in the distribution of the pandemic due to the presence of two phenomena characteristic of much of the south of the world: the fragmentation of the healthcare systems between public and private systems, and on the other hand, the concentration of extreme poverty that are the inhabitants of the slums.[7] The slums represent the extreme stratum of urban poverty and constitute a case of special vulnerability due to their overcrowded housing conditions and lack of basic resources that make it difficult to comply with social distancing measures.[8 9]

Although there is interest from the international community[10] about what might be expected from the development of the pandemic in these social groups, so far there are no reports of this topic in the literature. Latin America is currently one of the continents most affected by the epidemic and is also the continent with the greatest social inequality.[11 12]

Around 3 million people live in the city of Buenos Aires, of which between 7% and 10% have a residence in a slum.[13] Argentina behaved more restrictively than its neighbours and on 20 March established a strict lockdown strategy. Additionally, starting from the 13th week, a strategy of active search of cases in slums and vulnerable communities was established. This study reports the development of the COVID-19 epidemic in Buenos Aires with particular emphasis on the social distribution of the infection among the different socioeconomic strata of the city and slum dwellers, using a time-series analyses.

METHODS

All persons who meet the definition of suspected case for COVID-19 infection are systematically reported in the Argentine Integrated Health Information System (SISA). The report includes detailed demographic information including age, gender, place of residence and social security, as well as the description of the healthcare provider. The system also has clinical information that includes the date of onset of symptoms, clinical features and outcomes of cases describing whether the person was hospitalised or required critical care. This dataset is updated daily in order to qualify the status of active or closed case as well as information on the vital status of each person. The present manuscript includes all the people registered into the SISA database from 31 January to 14 July 2020 in CABA. Due to the fact that it takes about a week to update the database with the laboratory results, this analysis reports all data reported up to 7 July 2020. Although the first confirmed case of COVID-19 in Argentina was reported on 2 March 2020 in a 43-year-old person who had returned from a trip in an endemic circulation area, 13 suspected cases were tested before this first confirmed case. During the period analysed in the manuscript, the two kits that were mostly used for assessments were the RealStar SARS-CoV-2 RTPCR Kit 1.0 (Altona diagnostics, Germany) which has reported a sensitivity of 97.8% and specificity of 97.3%. To a lesser extent, the GeneFinder COVID-19 Plus RealAmp Kit was used, which has a reported sensitivity of 97.4% and specificity of 100%.

Slums

The definition of slum was made according to the address provided by each person to the health personnel involved in the identification of cases. Although the definition of slum is not universal, in the city of Buenos Aires it is defined as an unplanned settlement characterised by a high population density and consisting of precarious housing with high levels of unsatisfied basic needs. The cartography of the city's communes as well as the location of the slums can be consulted on the city's government website (https://www.estadisticaciudad.gob.ar/eyc/?p=45322) and https://www.buenosaires.gob.ar/areas/educacion/dirinv/pdf/villas_nht_y_nuevos_asentamientos.pdf). There are 38 mapped slums in the city, 6 of the 38 slums are home to almost 50% of the total slum population (Villa 1-11-14, n=26 000; Villa 15, n=20 000; Villa 20, n=20 000; Villa 21–24, n=30 000; Villa 31, n=45 000; Villa R Bueno, n=5000). However, this analysis describes the epidemiological situation in all the slums of the city.

Data analysis

All persons tested for suspected case of COVID-19 residing in CABA were included in the analysis. The characteristics of patients with either confirmed or ruled-out COVID-19 infection are described using numbers and percentage for categorical attributes, and means and SD for numerical variables with normal distributions. The differences between groups of interest were tested using the X^2 test for discrete variables and the T or Wilcoxon-Mann-Whitney test for numerical variables with normal and abnormal distribution, respectively. In order to determine independent variables that are associated with a positive real-time quantitative RT-PCR for SARS-CoV-2, a multiple logistic regression was settled. Results are reported using the central estimator and the 95% CI.

The calculation of incidence rates of COVID-19 infection per 100 000 people was made by age groups (eight groups of 10 years each and a group of people ≥80 years) considering population census figures. The total number of people living in slums was considered to be 7.6% of the total population of CABA projected to year 2020. The composition by age groups within the slum was taken from the census that the government of CABA made on the biggest slum in CABA (Villa 31, n=40 000). The composition of the different age strata outside the slums was taken from the national census.

In order to estimate the effects of living in a slum on incidence rate of COVID-19, Poisson regression models were used. Age strata were the independent variable, while the incidence rate of COVID-19 infection was the dependent variable.

In order to evaluate the effect that socioeconomic differences have on the incidence rates of COVID-19 infection regardless of the slums, an ecological analysis was carried out taking into account the social and economic indicators of each of the 15 communes of the city (average population per commune=188 685±27 456). The economic, social and demographic characterisation of each one of the communes arises from the national census that is not carried out in the slums and therefore is an indicator of the conditions of the communes without considering the slums that are located in each commune. Additionally, the government of the city of Buenos Aires maintains up-to-date statistics that measure various indicators of deprivation at the level of each of the 15 communes. These include the average income of a family, the type of employment and economic activity, the years of education (both as a categorical or continuous variable), the type of medical insurance (public and private) and the housing conditions. For the purposes of this paper, each commune was scored on the basis of each of these domains. This score was subsequently divided

into quintiles, which were used as an index of deprivation (with the higher values indicating greater deprivation). The quintiles were introduced into all risk models by adjusting for the average age of each commune.

The incidence rate for COVID-19 of each of the communes arises from the notification of cases in people with domiciles outside the slums. The denominator of each of the communes results from the census estimates for 2020 by subtracting the number of people living in the slum in each of the communes.

Socioeconomic condition was characterised based on the degree of unsatisfied basic needs (UBNs) at the level of each of the 15 communes of CABA. In order to estimate the effects of UBN, Poisson regression models were used. Quintiles of UBN were the independent variable, while the incidence rate from COVID-19 infection was the dependent variables. To evaluate the presence of differential effects of potential demographic differences between departments, age and gender composition were added to the models. Results are presented as incidence rate ratio (IRR) which is defined as the incidence rate among slum dwellers divided by the incidence rate of those people not living in a slum.

All analyses were two-tailed, and a p value of <0.05 was considered statistically significant. Statistical computations were conducted using R V.3.6.1 for Windows (R Foundation for Statistical Computing, Vienna).

Patient and public involvement

Patients and the public were not directly involved in the present study.

RESULTS

From the first reported case, a total of 114 052 people were tested for symptoms related with COVID-19. Of these, 39 039 (34.2%) were RT-PCR positive.

The infection began to spread outside the slums with a rapid increase until week 5 of the series, when the policy of social distancing began. In fact, since the introduction of restrictive measures to the circulation, the behaviour of the epidemic had a flattened curve from week 5 to 11 (table 1 and figure 1A). On the other hand, the viral circulation started in the fifth week in the slums with a very fast growth that was nuanced from the beginning of active search strategies ('DetecAR') of cases (table 1 and figure 1B). The demographic characteristics of slum dwellers and non-slum dwellers are presented in table 2.

In a regression model that takes into account demographic factors (age and gender), self-reported comorbidities (hypertension, diabetes), obesity and health financing, living in a slum was associated with a higher probability of having COVID-19 disease (2.38 (2.31 to 2.46), p<0.0001).

Table 1 Number of tests and percentage of positivity per week among slum dwellers and non-slum dwellers

		Residents not living in a slum								Slum residents							
Week	Ending	Assays	Test/M	Positive	%	Age	SD	Men	%	Assays	Test/M	Positive	%	Age	SD	Men	%
1	2/5	4	1	0	0	33.8	5.3	1	25	0	0	0	0	—	—	0	0
2	3/3	17	6	1	5.9	38.3	14.5	10	58.8	0	0	0	0	—	—	0	0
3	3/10	86	30	12	14	44.5	19.9	43	50	0	0	0	0	—	—	0	0
4	3/17	299	105	57	19.1	37.9	19.4	135	45.2	8	34	0	0	37	18	5	62.5
5	3/24	480	169	155	32.3	43.3	21.1	252	52.5	8	34	1	12.5	23.9	18	5	62.5
6	3/31	854	301	156	18.3	51.1	23.6	433	50.7	31	133	8	25.8	40.5	25.2	17	54.8
7	4/7	1621	570	172	10.6	44.8	24	814	50.2	124	530	15	12.1	28.3	19.5	59	47.6
8	4/14	1634	575	106	6.5	45.3	24.4	808	49.4	138	590	16	11.6	31	22	72	52.2
9	4/21	2303	810	157	6.8	46.2	24.1	1111	48.2	193	826	34	17.6	32.2	19.8	93	48.2
10	4/28	2392	842	236	9.9	48	25.7	1096	45.8	322	1378	136	42.2	29.8	18.1	147	45.7
11	5/5	2453	863	142	5.8	47.9	25.4	1153	47	440	1882	247	56.1	29.5	17.2	211	48
12	5/12	2719	957	337	12.4	47.3	25	1293	47.6	1039	4445	705	67.9	31.3	18.2	537	51.7
13	5/19	3475	1223	542	15.6	47	25.1	1630	46.9	1661	7106	1070	64.4	29.7	18	739	44.5
14	5/26	4715	1659	1034	21.9	43.3	23.5	2215	47	2819	12060	1569	55.7	28.7	17.3	1364	48.4
15	6/2	5335	1877	1361	25.5	44.1	23.4	2324	43.6	2859	12231	1428	49.9	28.2	17.7	1352	47.3
16	6/9	5997	2110	1758	29.3	43.7	23.2	2826	47.1	2859	12231	1447	50.6	28.9	18.1	1367	47.8
17	6/16	7262	2555	2405	33.1	43.8	23.1	3262	44.9	3479	14883	1692	48.6	29	17.2	1629	46.8
18	6/23	9630	3389	3466	36	42.9	22	4466	46.4	4226	18079	2099	49.7	30	17.8	2097	49.6
19	6/30	10202	3590	3639	35.7	41.8	21.7	4742	46.5	4713	20163	2255	47.8	28.6	17.5	2266	48.1
20	7/7	11477	4038	4548	39.6	42.9	22.4	5342	46.5	3595	15380	1656	46.1	29.8	18.2	1769	49.2
21	7/14	10459	3680	3450	33	44.3	22.3	4840	46.3	2124	9087	927	43.6	30.3	18.2	1022	48.1

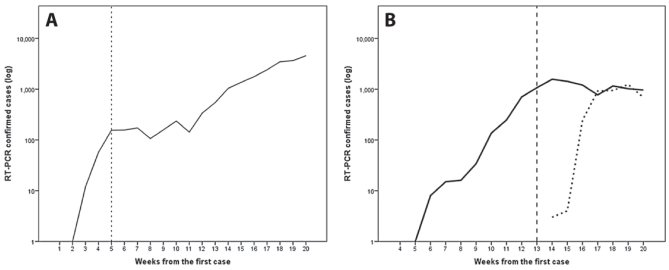

Figure 1 Evolution of the COVID-19 RT-PCR curve in people living outside the slums (A) and between resident slums (B).

COVID-19 incidence rate

The incidence rate for COVID-19 in the city of Buenos Aires towards the end of the 20th week was 201.7 (196.7 to 206.73) per 100 000 people. This rate was significantly different among people living in slums compared with those who did not. The incidence rates of COVID-19 infection were 160.0 (155.4 to 164.7) per 100 000 people among the inhabitants who did not reside in the slums (n=2 841 997) and 708.4 (674.5 to 742.5) among those who had a residence in the slum (233 749) (IRR 11.08 (10.51 to 11.68), p<0.0001) (table 3).

This difference was present in all age groups at the end of the 20th week (table 4 and figure 2).

Socioeconomic status of communes and COVID-19 incidence rate

The distribution of the incidence rate for COVID-19 was related to the level of unsatisfied basic needs for each of the city's neighbourhoods. Excluding the slums, compared with those communes with better social and economic situation (1.00), the progressive deprivation quintiles were associated with a higher probability of infection 1.36 (1.25 to 146); 1.61 (1.49 to 1.74); 1.86 (1.73 to 2.01) and 2.94 (2.74 to 3.16) for quintiles 2–5, respectively. The inclusion of slums, on the other hand, carries a risk of 14.4 (13.4 to 15.4) (table 5).

Table 2 Demographic and clinical presentation characteristics among slum dwellers and non-slum dwellers

	Non-slum residents	Slum residents	
n	23 734	15 305	P value
Gender—female, n (%)	11 824 (49.8)	7740 (50.6)	<0.0001
Gender—male, n (%)	11 803 (49.7)	7522 (49.1)	
None declared, n (%)	107 (0.4)	43 (0.3)	
Mean age (SD)	43.9 (22.2)	30.9 (17.6)	<0.0001
Age 0–39 years, n (%)	11 400 (48.0)	10 731 (70.1)	<0.0001
Age 40–59 years, n (%)	6834 (28.8)	3626 (23.6)	
Age ≥60 years, n (%)	5485 (23.1)	943 (6.2)	
Declared diseases and conditions			
Asthma, n (%)	603 (2.5)	540 (3.5)	<0.0001
Diabetes, n (%)	858 (3.6)	566 (3.7)	0.669
COPD, n (%)	277 (1.2)	34 (0.2)	<0.0001
Hypertension, n (%)	1960 (8.3)	680 (4.4)	<0.0001
Chronic heart failure, n (%)	332 (1.4)	57 (0.4)	<0.0001
Obesity (≥30 BMI), n (%)	640 (2.7)	485 (3.2)	0.006
Current smoker, n (%)	732 (3.1)	622 (4.1)	<0.0001

BMI, body mass index; COPD, chronic obstructive pulmonary disease.

Table 3 Weekly incidence rates between residents outside and inside the slums

	Residents not living in a slum			Slum residents		
Week	Incidence rate	Lower 95% CI	Upper 95% CI	Incidence rate	Lower 95% CI	Upper 95% CI
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.1	0.0	0.0	0.0
3	0.4	0.2	0.7	0.0	0.0	0.0
4	2.0	1.5	2.5	0.0	0.0	0.0
5	5.5	4.6	6.3	0.4	0.4	1.3
6	5.5	4.6	6.4	3.4	1.1	5.8
7	6.1	5.2	7.0	6.4	3.2	9.7
8	3.7	3.0	4.4	6.8	3.5	10.2
9	5.5	4.7	6.4	14.6	9.7	19.4
10	8.3	7.2	9.4	58.2	48.4	68.0
11	5.0	4.2	5.8	105.7	92.5	118.8
12	11.9	10.6	13.1	301.6	279.4	323.8
13	19.1	17.5	20.7	457.8	430.4	485.1
14	36.4	34.2	38.6	671.2	638.1	704.3
15	47.9	45.4	50.4	610.9	579.3	642.5
16	61.9	59.0	64.8	619.0	587.2	650.8
17	84.6	81.2	88.0	723.9	689.5	758.2
18	122.0	117.9	126.0	898.0	859.7	936.2
19	128.0	123.9	132.2	964.7	925.1	1004.3
20	160.0	155.0	165.0	708.0	674.0	742.0
21	121.4	117.4	125.4	396.6	371.1	422.1

OUTCOMES

Hospitalisations

A total of 11 671 people were hospitalised. Among these, 5116 (43.8%) were admitted to a public hospital and approximately half of these (2350%–46.2%) were slum dwellers.

Of those hospitalised persons, those with residence in a slum were significantly younger (35.6±20.8 years) than those living out of slum (50.0±23.9 years, (p<0.0001)). Despite this, the requirement for intensive care assistance was similar (225/3193 (7.0%)) among people with residence in the slum and 575/8478 (6.8%) among people outside the slums.

Mortality

Of the 39 039 patients who tested positive for COVID-19, at the time of this analysis, a total of 729 people (1.86%) died, of whom 150 (20.6%) resided in a slum.

In age-corrected and sex-corrected regression models including comorbidities (asthma, diabetes, chronic lung disease, hypertension, heart failure, renal failure), obesity

Table 4 Incidence rates at week 20 among residents in and out of slums by age group

Age group	Residents not living in a slum			Slum residents					
	Incidence rate	Lower 95% CI	Upper 95% CI	Incidence rate	Lower 95% CI	Upper 95% CI	IRR	Lower 95% CI	Upper 95% CI
0–9	60.5	52.6	68.4	346.9	298.1	395.8	5.689	4.333	7.468
10–19	76.5	67.5	85.5	522.6	456.3	589.0	6.882	5.41	8.753
20–29	193.0	179.0	207.0	627.8	563.2	692.4	3.254	2.769	3.823
30–39	208.3	194.6	222.0	860.9	768.1	953.6	4.139	3.558	4.816
40–49	194.9	181.2	208.7	1156.5	1012.8	1300.2	5.933	5.098	6.905
50–59	188.9	173.4	204.4	1618.3	1379.8	1856.8	8.561	7.364	9.953
60–69	143.3	129.1	157.6	2110.7	1634.9	2586.5	14.762	12.462	17.487
70–79	153.1	136.1	170.2	2224.1	1378.8	3069.5	14.536	12.34	17.123
≥80	291.8	263.1	320.4	7265.0	3939.2	10590.7	24.88	22.133	27.968

IRR, incidence rate ratio.

and current smoker living in a slum were associated with an increased risk of dying (2.40 (1.95 to 2.95), p<0.0001).

DISCUSSION

Twenty weeks after the first case was reported in the city of Buenos Aires, the COVID-19 pandemic is focusing on the city's most economically vulnerable social groups. Although slum dwellers represent 7% of the city's population, they contribute 40% of the cases. However, absolute numbers do not accurately reflect the amount of inequitable distribution. Age-adjusted stratified incidence rates differ in astronomical proportions. For each age range, the minimum difference is a magnitude of 3 times; and for groups of people over 50 years, the differences exceed the range of 14 times more. These differences also extend to mortality, where slum dwellers, despite being younger, have higher mortality. Beyond the metrics that characterise slums, it is important to consider that

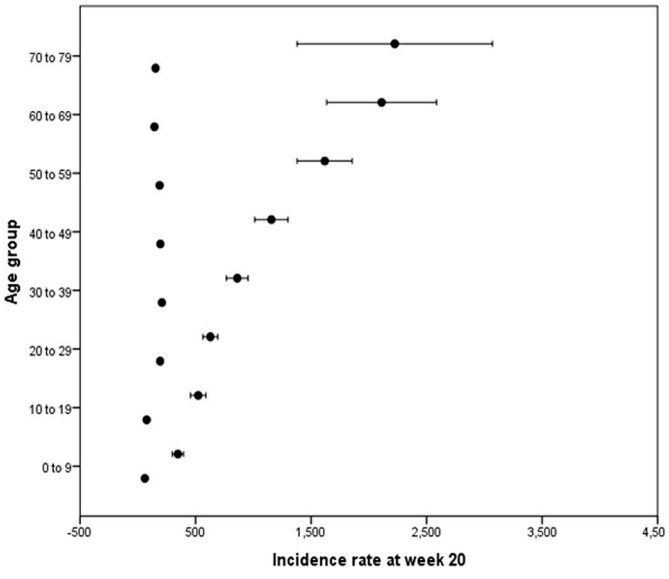

Figure 2 Difference in incidence rates by age group in week 20 between inhabitants with and without residence in the slums.

half of the households in slums do not have sewage disposal, those one-third are critically overcrowded and that one in four does not have main water. Eighty per cent of adults over 25 years of age have not completed secondary education.

The most recent estimates for slum populations suggest that nearly 900 million people live in slums in the developing world, and it is estimated that by 2030, about 2 out of 5 billion of the world's people will live in slums located mostly in big cities.[8 9] Despite this, health in slums can be considered poorly studied. Moreover, slums are not identified as a determinant of health in the Global Burden of Disease report.

This report actually shows that slum residents cannot be considered an extension of urban poverty or a mere risk category. Slums constitute an individual reality with its own identity and a dynamism that can only be managed as such. The health strategies in the city of Buenos Aires were in fact not an extension of the approach to the problem in the rest of the city. The active search for suspicious cases and an intensive testing plan resulted in a flattening of the slum curve. Although the positivity rate remains high, the progression of the epidemic could only be contained by a non-passive strategy. The slums, although more concentrated in the south of the city, are distributed throughout the city. In fact,

Table 5 Social gradient in the distribution of incidence rates between the different neighbourhoods of the city and the slums

SES quintiles	IRR	Lower 95% CI	Upper 95% CI	P value
1	1			
2	1.358	1.259	1.465	<0.0001
3	1.611	1.492	1.741	<0.0001
4	1.865	1.729	2.012	<0.0001
5	2.943	2.738	3.162	<0.0001
Slum	14.375	13.413	15.407	<0.0001

IRR, incidence rate ratio; SES, socioeconomic status.

the largest conglomerate is located in close proximity to one of the city's most affluent neighbourhoods. Therefore, it is not the geographical distribution but the social conditions that determine the results.

In the rest of the city where the majority of the population lives, it is also observed that the distribution of the infection is socially conditioned. This phenomenon was described in other large cities such as New York or Chicago[1–5] where there is a disproportionate representation of cases between the black and Latino communities.

Although previous theoretical models elegantly documented that an eventual pandemic similar to that of 1918 would have events concentrated in the poor world[14] with more than 95% of the victims among the most disadvantaged social groups, the verification of this asymmetry in a concrete reality and in short times is one more example that the inequality of the world of a century ago is still in force.

Despite mathematical models describing what could theoretically happen in the developing world,[15–17] this is—to the best of our knowledge—the first concrete communication of the evolving of the pandemic among slum dwellers in a large city. The rigorousness of the health information system in Argentina contributes enormously to the description of this phenomenon. It is possible that countries with a similar or greater disease burden than Argentina may not be able to complete a survey of these characteristics due to fragmented or incomplete reporting systems. Although incidence rates cannot be extrapolated to other settings, the underlying concept is one of international relevance.

This analysis finds associations between place of residence and population incidence rates and does not give or pretend to give a mechanistic explanation of why these differences occur. Many factors can be related to these findings. The overcrowding of slums and the lack of basic services must certainly play a role in the impossibility of achieving adequate social distance. But not only material deprivation plays a role. Fear of losing a job due to absenteeism may mean that consultations for symptoms may be delayed among slum dwellers. In any case it is important to investigate these reasons and in no way to prejudge or give rise to a stigmatisation that is a well-described phenomenon and should be avoided.[18]

Contributors AM, FGBdQ and DF conceived the study. JM and GB made statistical and conceptual inputs. All authors are guarantors for the study. All authors revised the manuscript, provided critical scholarly feedback and approved the final version of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data can be requested from the corresponding author citing a reasonable request.

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