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All-cause and COVID-19 mortality in Qatar during the COVID-19 pandemic

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ABSTRACT

Objective To investigate all-cause mortality, COVID-19 mortality and all-cause non-COVID-19 mortality in Qatar during the COVID-19 pandemic.

Methods A national, retrospective cohort analysis and national, matched, retrospective cohort studies were conducted between 5 February 2020 and 19 September 2022.

Results There were 5025 deaths during a follow-up time of 5 247 220 person-years, of which 675 were COVID-19 related. Incidence rates were 0.96 (95% CI 0.93 to 0.98) per 1000 person-years for all-cause mortality, 0.13 (95% CI 0.12 to 0.14) per 1000 person-years for COVID-19 mortality and 0.83 (95% CI 0.80 to 0.85) per 1000 person-years for all-cause non-COVID-19 mortality. Adjusted HR, comparing all-cause non-COVID-19 mortality relative to Qataris, was lowest for Indians at 0.38 (95% CI 0.32 to 0.44), highest for Filipinos at 0.56 (95% CI 0.45 to 0.69) and was 0.51 (95% CI 0.45 to 0.58) for craft and manual workers (CMWs). Adjusted HR, comparing COVID-19 mortality relative to Qataris, was lowest for Indians at 1.54 (95% CI 0.97 to 2.44), highest for Nepalese at 5.34 (95% CI 1.56 to 18.34) and was 1.86 (95% CI 1.32 to 2.60) for CMWs. Incidence rate of all-cause mortality for each nationality group was lower than the crude death rate in the country of origin.

Conclusions Risk of non-COVID-19 death was low and was lowest among CMWs, perhaps reflecting the healthy worker effect. Risk of COVID-19 death was also low, but was highest among CMWs, largely reflecting higher exposure during first epidemic wave, before advent of effective COVID-19 treatments and vaccines.

INTRODUCTION

Qatar, with a multinational population of 2.8 million people, has a unique sociodemographic structure, where single-unit and family households including children, adults and/or older adults account for only 40% of the total population.[1 2] This demographic segment of the population is commonly labelled in Qatar as the 'urban population' though socioeconomically it consists predominantly of white-collar workers and their families.[3] Adults in the urban population typically work in the professional or service workforce, either private or governmental.[1–3] The main defining feature of this part of the population is that its members are not migrant blue-collar craft and manual workers (CMWs). Migrant blue-collar CMWs comprise the remaining 60% of the population[4 5] and are typically single men, 20–49 years of age, working in development projects[2] and living in large shared accommodations.[6] Both the urban and CMW populations live in urban areas, mostly in Doha, the capital city, with a negligible part of the population living outside urban areas.[7]

Nearly 89% of Qatar's population are expatriates from over 150 countries.[1 2 8 9] By nationality, Indians (28%), Bangladeshis (13%) and Nepalese (13%) are the most populous groups followed by Qataris (11%) and Filipinos (7%).[1 2 8 9] Nearly all Bangladeshis and Nepalese are part of the CMW population. Meanwhile, Indians and Filipinos are distributed among the CMW and urban populations, but with most Indians being part of the CMW population and most Filipinos being part of the urban population.[1 2 8 9] Most remaining nationalities, along with Qataris, are part of the urban population.[1 2 8 9] Females account for only a quarter of Qatar's population, the majority of whom are part of the urban population.[7]

The first documented community transmission case of SARS-CoV-2 in Qatar was identified on 6 March 2020 and was linked to a cluster of about 300 infections among CMWs living in a high-density housing accommodation.[9 10] Since then, Qatar experienced six SARS-CoV-2 epidemic waves dominated sequentially by the original virus (2020),[11] Alpha (2021),[12] Beta (2021),[13] Omicron BA.1 and BA.2 (end of 2021 and 2022),[14] Omicron BA.4 and BA.5 (2022)[15] and Omicron BA.2.75.2 (2022),[16] in

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ SARS-CoV-2 infection causes COVID-19 mortality.
⇒ COVID-19 deaths may occur due to factors related to the virus, the host or availability of vaccinations and treatments.
⇒ There appear to be large variations in COVID-19 mortality and all-cause mortality rates across countries during the COVID-19 pandemic for reasons that remain inadequately understood.
⇒ Qatar, with a multinational population of 2.8 million people, has a unique sociodemographic structure.
⇒ About 60% of the population consists of craft and manual workers.
⇒ Mortality rates among these low-socioeconomic status workers have been subject to debate in the absence of epidemiological assessment.

WHAT THIS STUDY ADDS

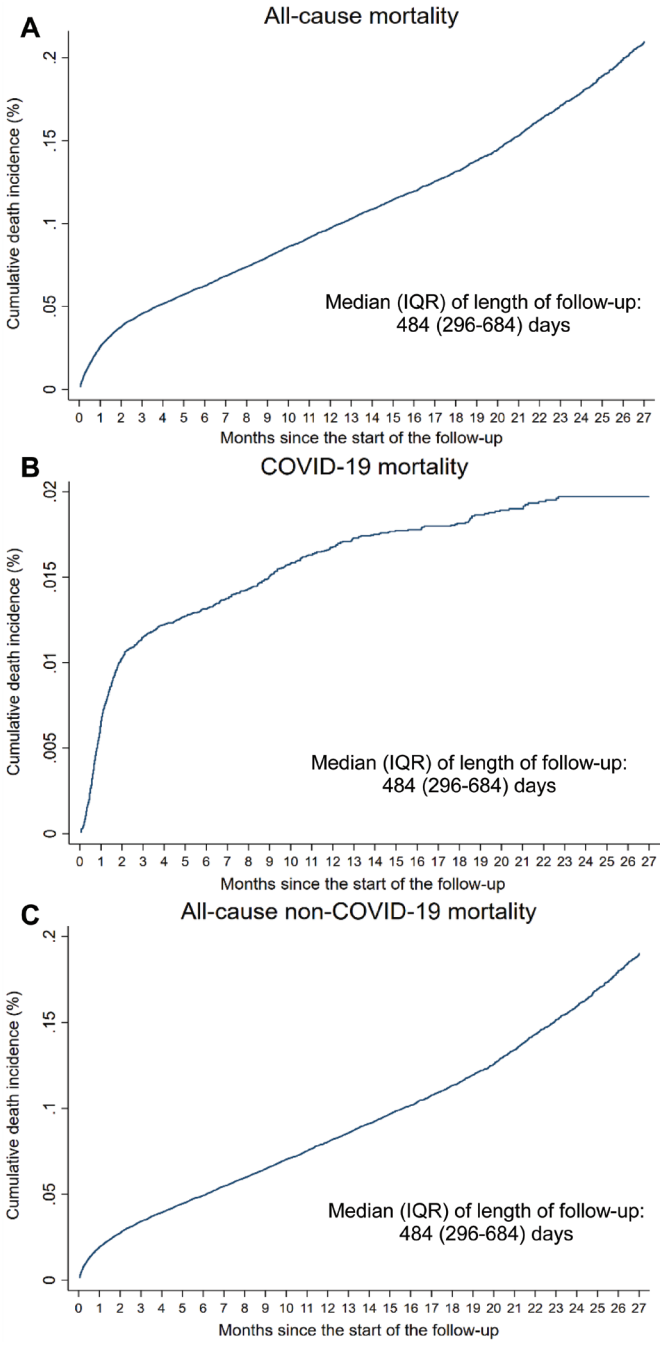
⇒ Risk of COVID-19 death was very low in the population of Qatar during the COVID-19 pandemic at 0.13 deaths for every 1000 individuals per year.
⇒ Risk of COVID-19 death was highest among craft and manual workers and lowest among Qataris who have a high socioeconomic status, but this difference largely reflected differential exposure to the first epidemic wave.
⇒ Risk of all-cause death was low in the population of Qatar during the COVID-19 pandemic at 0.96 deaths for every 1000 individuals per year.
⇒ Risk of non-COVID-19 death was highest among Qataris and lowest among craft and manual workers, apparently reflecting the healthy worker effect.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Craft and manual workers in Qatar are healthy by recruitment and maintain high levels of physical activity perhaps explaining their lowest rate of all-cause mortality.
⇒ Qataris are a typical national population that includes both healthy and unhealthy individuals, perhaps explaining their highest rate of all-cause mortality.
⇒ COVID-19 mortality rates show large variations within countries and across countries, with some countries like Qatar experiencing unusually low COVID-19 mortality rates.

addition to a prolonged low-incidence phase dominated by Delta (mid to end of 2021) (online supplemental figure S1).[17 18] CMWs were the most affected population by the first epidemic wave, a consequence of living in large shared accommodations.[3–5 9 19 20] By the end of the first wave, most CMWs had detectable antibodies against SARS-CoV-2.[3–5 9 19] Subsequent waves affected all population sectors in the country.[11–16]

We investigated all-cause mortality, COVID-19 mortality and all-cause non-COVID-19 mortality in Qatar's population since the onset of the COVID-19 pandemic. We further investigated differences in mortality risk by major nationality groups and socioeconomic sectors (CMW vs urban populations), after adjustment for confounding factors (sex, age and existing comorbid conditions).



IQR denotes interquartile range.

Figure 1 Cumulative incidence of death for (A) all-cause mortality, (B) COVID-19 mortality and (C) all-cause non-COVID-19 mortality in the population of Qatar.

METHODS

Study population and data sources

This study was conducted in the population of Qatar and analysed the national mortality database managed by Hamad Medical Corporation, the principal public healthcare provider in Qatar. This database includes all death records in Qatar, including deaths occurring at healthcare facilities and elsewhere. The database also includes forensic deaths investigated by Qatar's Ministry of Interior.

Table 1 Incidence rates of death for all-cause mortality, COVID-19 mortality and all-cause non-COVID-19 mortality by nationality compared with both the unadjusted and age-adjusted crude death rates in the country of origin, as estimated by the United Nations World Population Prospects for the year 2021[24]

	Incidence rate of death per 1000 person-years (95% CI)			Crude death rate per 1000 persons in 2021	
Nationality	All-cause mortality	COVID-19 mortality	All-cause non-COVID-19 mortality	United Nations World Population Prospects estimate	Age-adjusted* United Nations World Population Prospects estimate
Bangladeshis	0.78 (0.69 to 0.87)	0.17 (0.14 to 0.22)	0.60 (0.53 to 0.69)	5.68	2.15
Filipinos	0.61 (0.53 to 0.69)	0.14 (0.11 to 0.18)	0.47 (0.40 to 0.54)	7.31	4.70
Indians	0.49 (0.45 to 0.52)	0.09 (0.07 to 0.11)	0.40 (0.36 to 0.43)	9.45	2.47
Nepalese	0.42 (0.37 to 0.48)	0.05 (0.03 to 0.07)	0.37 (0.32 to 0.43)	7.77	3.11
Qataris	3.08 (2.94 to 3.24)	0.24 (0.20 to 0.28)	2.85 (2.71 to 2.99)	–†	–†
Total population	0.96 (0.93 to 0.98)	0.13 (0.12 to 0.14)	0.83 (0.80 to 0.85)	–	–

*Crude death rate in the country of origin as estimated by the United Nations World Population Prospects for the year 2021,[24] but adjusted for the age structure of each nationality group in the national cohort of those ever tested for SARS-CoV-2 in Qatar.
†The United Nations World Population Prospects[24] provides an estimate for only the total population of Qatar and does not provide an estimate for only Qataris. The estimate for the overall population is not representative of that of Qataris as Qataris comprise only 11% of the population of Qatar.[1 2 8 9]

The study also analysed the national, federated databases for COVID-19 laboratory testing, vaccination, hospitalisation and death, retrieved from the integrated, nationwide, digital health information platform (online supplemental section S1). Databases include all SARS-CoV-2-related data and associated demographic information, with no missing information, since the pandemic onset, such as all PCR tests, and starting from 5 January 2022 onwards, medically supervised rapid antigen tests. Detailed descriptions of Qatar's SARS-CoV-2 databases have been reported previously.[9 13 15 17 21–23]

Study design and cohorts

A national, retrospective cohort study was conducted to investigate the incidence of death in Qatar's population. Selection of the national cohort was based on presence of any record for a SARS-CoV-2 PCR or rapid antigen test, regardless of the test result, since the pandemic onset. Any individual with a record for a SARS-CoV-2 test between 5 February 2020 (earliest record for a SARS-CoV-2 test) and 19 September 2022 (end of study date) was eligible for inclusion in the study. Children <1 year old were excluded.

Testing for SARS-CoV-2 in Qatar is done at a mass scale, and mostly for routine reasons, whereby ~5% of the population is tested every week (online supplemental section S1).[17 22] With various testing mandates implemented throughout the COVID-19 pandemic and the large number of tests (14 487 641 tests from pandemic onset until 19 September 2022), it is not conceivable that any citizen or resident in Qatar had not had at least one SARS-CoV-2 test since the start of the pandemic. Accordingly, the SARS-CoV-2 testing database provided a sampling frame for the population of Qatar based on which this study was implemented.

Mortality in the national cohort of Qatar

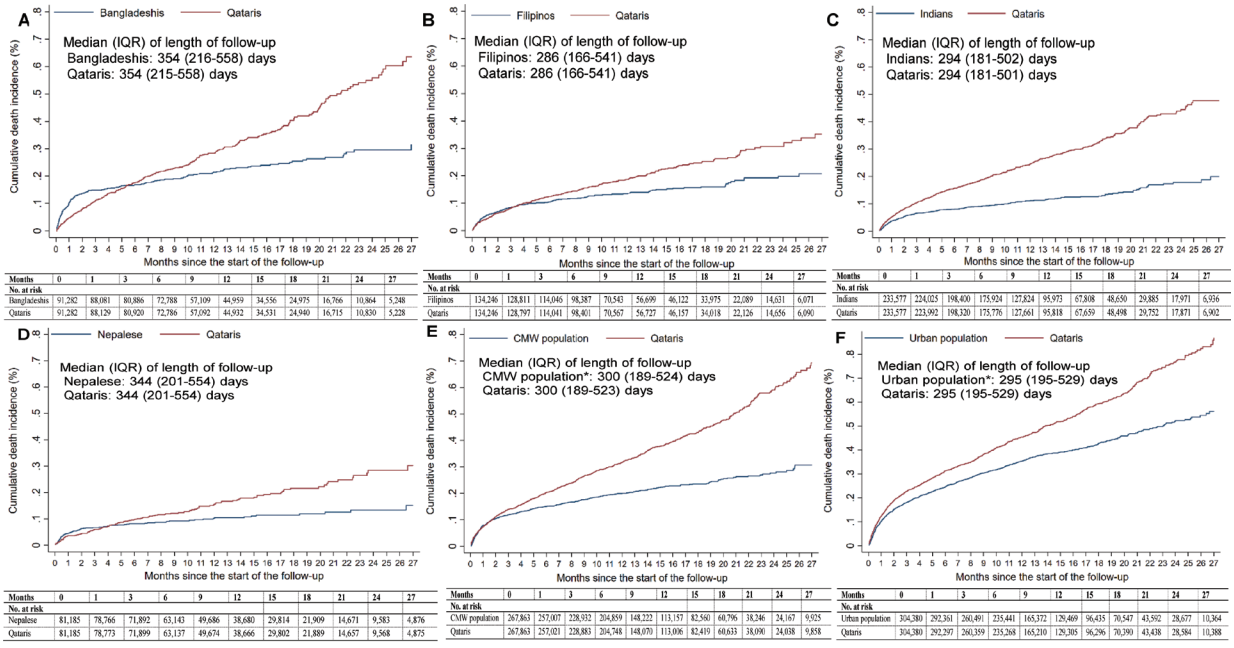
Incidence rates of all-cause mortality, COVID-19 mortality and all-cause non-COVID-19 mortality were assessed in the full national cohort. Individuals were followed from the calendar day of their first SARS-CoV-2 test until death or end of study censoring (19 September 2022). Outcomes were also assessed for major nationality groups (Bangladeshis, Filipinos, Indians, Nepalese and Qataris).

Incidence rate of death for all-cause mortality by nationality was compared with the crude death rate in countries of origin, as estimated by the United Nations (UN) World Population Prospects for 2021,[24] and also after adjustment for the age structure of each nationality group in the national cohort in Qatar.

Differences in mortality by nationality

A series of national, matched, retrospective cohort studies was conducted comparing incidence of death among each major nationality group in Qatar with incidence of death among Qataris. For each of these studies, individuals in the investigated nationality group cohort were exact matched one-to-one by sex, 10-year age group, existing comorbid conditions (none, one, two, three, four, five and six or more comorbidities; online supplemental section S1), SARS-CoV-2 testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test to Qatari individuals.

Matching was performed to balance observed confounders between the two exposure groups for factors that affect mortality risk, namely sex, age and comorbid conditions. That is, matching was only used to create similar cohorts and was not a criterion for conduct of further analysis. Matching by SARS-CoV-2 testing method was done because persons reporting symptoms are more likely to receive PCR than rapid antigen testing. Rapid antigen testing is mostly implemented in routine SARS-CoV-2 testing. Matching by calendar week of the



CMW denotes craft and manual workers, and IQR, interquartile range.
*CMW population includes Bangladeshis, Indians, Nepalese, Pakistanis, and Sri Lankans. Urban population includes all other expatriate nationalities residing in Qatar.

Figure 2 Cumulative incidence of death for all-cause mortality in major nationality groups in Qatar (panels A-F show, respectively, Bangladeshis, Filipinos, Indians, Nepalese, CMW population, and urban poulation) compared with Qataris.

SARS-CoV-2 test was done to ensure that paired individuals were in Qatar at the same time and to control for time-variable differences in mortality risk.

Matching was performed iteratively such that the identified match was alive at the start of follow-up. Matching was iterated with as many replications as needed until exhaustion of the sample, that is, until no more matched pairs with controls that fulfil the eligibility criteria could be identified. Each matched pair was followed from the calendar day of the SARS-CoV-2 test for the Qatari individual until death or end of study censoring (19 September 2022).

Differences in mortality by socioeconomic population sector

Two other national, matched, retrospective cohort studies were conducted comparing incidence of death among the CMW and urban populations with incidence of death among Qataris. These two studies used the same methods for matching and follow-up described above for differences in mortality by nationality.

Nationality is strongly associated with occupation in Qatar and provides a proxy for being a CMW and for socioeconomic status.[3–5 9 19] Accordingly, CMW was proxied by Bangladeshi, Indian, Nepalese, Pakistani and Sri Lankan nationalities,[3–5 9 19] while the urban population included all other expatriate nationalities residing in Qatar.

Classification of COVID-19 death

Classification of COVID-19 death followed WHO guidelines.[25] Assessments were made by trained medical personnel independent of study investigators and using individual chart reviews, as part of a national protocol applied to every deceased patient with COVID-19 since the pandemic onset.

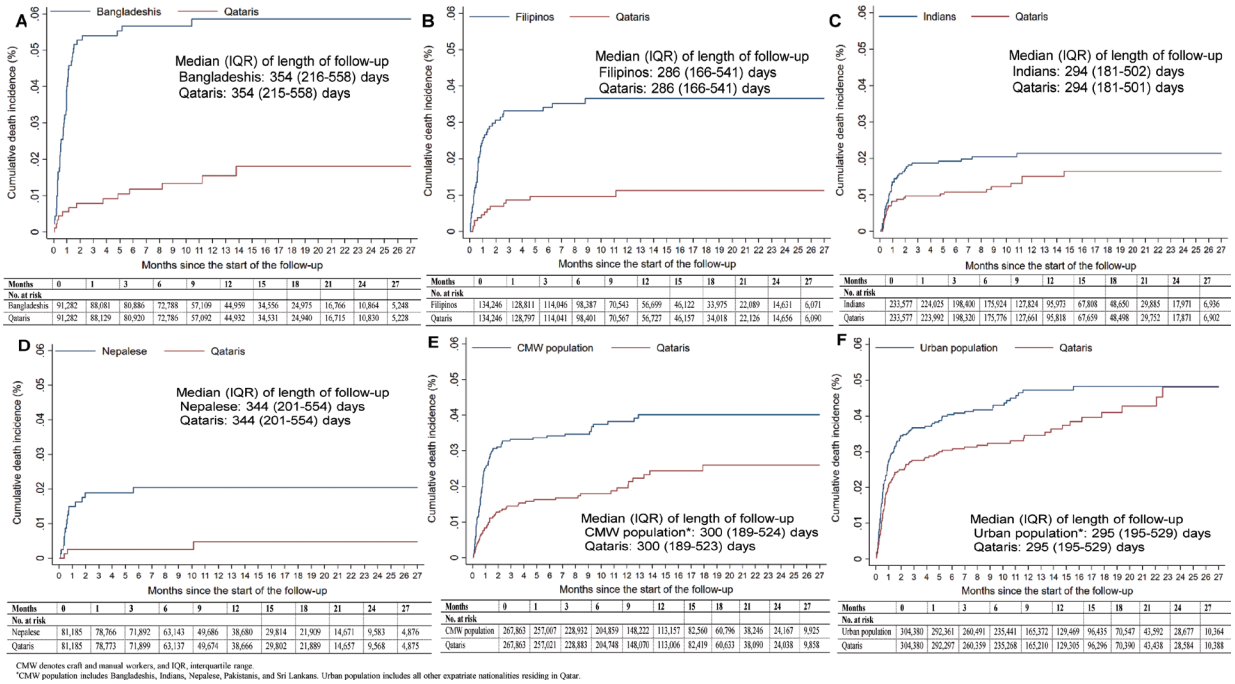
COVID-19 death was defined per WHO classification as 'a death resulting from a clinically compatible illness, in a probable or confirmed COVID-19 case, unless there is a clear alternative cause of death that cannot be related to COVID-19 disease (eg, trauma). There should be no period of complete recovery from COVID-19 between illness and death. A death due to COVID-19 may not be attributed to another disease (eg, cancer) and should be counted independently of preexisting conditions that are suspected of triggering a severe course of COVID-19'. Detailed WHO criteria for classifying COVID-19 deaths can be found in the WHO technical report.[25]

Patient and public involvement

Patients or the public were not directly involved in the design, conduct, reporting or dissemination plans of our research.

Statistical analysis

Cohorts were characterised using descriptive statistics and compared using standardised mean differences (SMDs). An SMD of ≤0.1 indicated adequate matching.[26] Cumulative incidence of death (defined as proportion of individuals at risk, whose primary endpoint during follow-up was death) was estimated using the Kaplan-Meier estimator method.[27] Incidence rate of death in each cohort, defined as number of deaths divided by number of person-years contributed by all individuals in the cohort, was estimated with corresponding 95% CI using a Poisson log-likelihood regression model with Stata V.17.0 *stptime* command.



Months	0	1	3	6	9	12	15	18	21	24	27
No. at risk											
Bangladeshis	91,282	88,081	80,886	72,788	57,109	44,959	34,556	24,975	16,766	10,864	5,248
Qataris	91,282	88,129	80,920	72,786	57,092	44,932	34,531	24,940	16,715	10,830	5,228

Months	0	1	3	6	9	12	15	18	21	24	27
No. at risk											
Filipinos	134,246	128,811	114,046	98,387	70,543	56,699	46,122	33,975	22,089	14,631	6,071
Qataris	134,246	128,797	114,041	98,401	70,567	56,727	46,157	34,018	22,126	14,656	6,090

Months	0	1	3	6	9	12	15	18	21	24	27
No. at risk											
Indians	233,577	224,025	198,400	175,924	127,824	95,973	67,808	48,650	29,885	17,971	6,936
Qataris	233,577	223,992	198,320	175,776	127,661	95,818	67,659	48,498	29,752	17,871	6,902

Months	0	1	3	6	9	12	15	18	21	24	27
No. at risk											
Nepalese	81,185	78,766	71,892	63,143	49,686	38,680	29,814	21,909	14,671	9,583	4,876
Qataris	81,185	78,773	71,899	63,137	49,674	38,666	29,802	21,889	14,657	9,568	4,875

Months	0	1	3	6	9	12	15	18	21	24	27
No. at risk											
CMW population	267,863	257,007	228,932	204,859	148,222	113,157	82,560	60,796	38,246	24,167	9,925
Qataris	267,863	257,021	228,883	204,748	148,070	113,006	82,419	60,633	38,090	24,038	9,858

Months	0	1	3	6	9	12	15	18	21	24	27
No. at risk											
Urban population	304,380	292,361	260,491	235,441	165,372	129,469	96,435	70,547	43,592	28,677	10,364
Qataris	304,380	292,297	260,359	235,268	165,210	129,305	96,296	70,390	43,438	28,584	10,388

CMW denotes craft and manual workers, and IQR, interquartile range.
*CMW population includes Bangladeshis, Indians, Nepalese, Pakistanis, and Sri Lankans. Urban population includes all other expatriate nationalities residing in Qatar.

Figure 3 Cumulative incidence of death for COVID-19 mortality in major nationality groups in Qatar (panels A-F show, respectively, Bangladeshis, Filipinos, Indians, Nepalese, CMW population, and urban poulation) compared with Qataris.

HRs, comparing incidence of death in the cohorts and corresponding 95% CIs, were calculated using Cox regression adjusted for matching factors with Stata V.17.0 *stcox* command. Schoenfeld residuals and log-log plots for survival curves were used to test the proportional hazards assumption. Interactions were not considered. Adjusted HRs were estimated by 3-month intervals since start of follow-up by restricting 'failures' to sequential 3-month intervals. Statistical analyses were conducted using Stata/SE V.17.0 (Stata, College Station, Texas, USA).

Oversight

The study was reported following the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (online supplemental table S1).

RESULTS

Mortality in the national cohort of Qatar

There were 5025 deaths recorded in the national cohort of all SARS-CoV-2-tested individuals over a follow-up time of 5 247 220 person-years, of which 675 were COVID-19 related. COVID-19 resulted in 682 deaths in Qatar from pandemic onset up to the end of the study, but six cases were diagnosed with SARS-CoV-2 after death, and thus were not part of the followed cohort. One additional COVID-19 death of a child <1 year old was excluded for age ineligibility.

The median follow-up time in the national cohort was 484 days (IQR 296–684 days). Cumulative incidence of death was 0.21% (95% CI 0.20% to 0.22%) for all-cause mortality, 0.02% (95% CI 0.02% to 0.02%) for COVID-19 mortality and 0.19% (95% CI 0.18% to 0.20%) for all-cause non-COVID-19 mortality, after 27 months of follow-up (figure 1). The most rapid increase in COVID-19 mortality occurred just after the start of follow-up, during the first epidemic wave (figure 1 and online supplemental figure S1).

Incidence rate of death in this national cohort was 0.96 (95% CI 0.93 to 0.98) per 1000 person-years for all-cause mortality, 0.13 (95% CI 0.12 to 0.14) per 1000 person-years for COVID-19 mortality and 0.83 (95% CI 0.80 to 0.85) per 1000 person-years for all-cause non-COVID-19 mortality (table 1).

By nationality, incidence rate of death for all-cause mortality was lowest among Nepalese at 0.42 (95% CI 0.37 to 0.48) per 1000 person-years and highest among Qataris at 3.08 (95% CI 2.94 to 3.24) per 1000 person-years (table 1). Incidence rate of death for COVID-19 mortality was lowest among Nepalese at 0.05 (95% CI 0.03 to 0.07) per 1000 person-years and highest among Qataris at 0.24 (95% CI 0.20 to 0.28) per 1000 person-years. Incidence rate of death for all-cause non-COVID-19 mortality was lowest among Nepalese at 0.37 (95% CI 0.32 to 0.43) per 1000 person-years and highest among Qataris at 2.85 (95% CI 2.71 to 2.99) per 1000 person-years.

Incidence rate of death for all-cause mortality for each expatriate nationality group was substantially lower than both the unadjusted and age-adjusted crude death rates in countries of origin (table 1).

Differences in mortality by nationality

Online supplemental tables S2 and S3 describe baseline characteristics of matched cohorts in national, matched, retrospective cohort studies comparing incidence of death among major expatriate nationality groups with incidence of death among Qataris.

Table 2 HRs comparing risk of death for all-cause mortality in major nationality groups in Qatar relative to Qataris

Pairwise comparison*	Cohort size	Deaths	Total follow-up time in person-years	Incidence rate of death per 1000 person-years (95% CI)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)†
Bangladeshis versus Qataris						
Bangladeshis	91 282	196	97 020	2.02 (1.76 to 2.32)	0.69 (0.58 to 0.83)	0.69 (0.58 to 0.83)
Qataris	91 282	284	96 980	2.93 (2.61 to 3.29)		
Filipinos versus Qataris						
Filipinos	134 246	177	130 981	1.35 (1.17 to 1.57)	0.71 (0.59 to 0.87)	0.71 (0.59 to 0.87)
Qataris	134 246	248	130 930	1.89 (1.67 to 2.15)		
Indians versus Qataris						
Indians	233 577	245	218 735	1.12 (0.99 to 1.27)	0.44 (0.38 to 0.51)	0.44 (0.38 to 0.51)
Qataris	233 577	553	218 451	2.53 (2.33 to 2.75)		
Nepalese versus Qataris						
Nepalese	81 185	81	85 130	0.95 (0.77 to 1.18)	0.62 (0.47 to 0.82)	0.62 (0.47 to 0.82)
Qataris	81 185	131	85 110	1.54 (1.30 to 1.83)		
CMW population‡ versus Qataris						
CMW population	267 863	508	257 908	1.97 (1.81 to 2.15)	0.60 (0.54 to 0.67)	0.59 (0.53 to 0.66)
Qataris	267 863	850	257 629	3.30 (3.08 to 3.53)		
Urban population‡ versus Qataris						
Urban population	304 380	1006	294 500	3.42 (3.21 to 3.63)	0.74 (0.69 to 0.81)	0.74 (0.68 to 0.80)
Qataris	304 380	1352	294 206	4.60 (4.36 to 4.85)		

*Cohorts were exact matched one-to-one by sex, 10-year age groups, comorbidity count, testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test.
†Cox regression analysis adjusted for sex, 10-year age groups, comorbidity count, SARS-CoV-2 testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test.
‡CMW population includes Bangladeshis, Indians, Nepalese, Pakistanis and Sri Lankans. Urban population includes all other expatriate nationalities residing in Qatar.
CMW, craft and manual worker.

Cumulative incidence of death for all-cause mortality, COVID-19 mortality and all-cause non-COVID-19 mortality is shown in figures 2 and 3 and online supplemental figure S2, respectively. Corresponding incidence rates are shown in tables 2–4, respectively. Differences by nationality were observed. All-cause non-COVID-19 mortality was higher among Qataris than among the major expatriate nationality groups. However, COVID-19 mortality was higher among the major expatriate nationality groups than among Qataris.

Adjusted HR comparing all-cause mortality relative to Qataris was lowest for Indians at 0.44 (95% CI 0.38 to 0.51) and highest for Filipinos at 0.71 (95% CI 0.59 to 0.87) (table 2). Adjusted HR comparing COVID-19 mortality relative to Qataris was lowest for Indians at 1.54 (95% CI 0.97 to 2.44) and highest for Nepalese at 5.34 (95% CI 1.56 to 18.34) (table 3). Adjusted HR comparing all-cause non-COVID-19 mortality relative to Qataris was lowest for Indians at 0.38 (95% CI 0.32 to 0.44) and highest for Filipinos at 0.56 (95% CI 0.45 to 0.69) (table 4).

Differences in mortality by socioeconomic population sector

Online supplemental table S3 describes baseline characteristics of matched cohorts in national, matched, retrospective cohort studies comparing incidence of death among each of the CMW and urban populations with incidence of death among Qataris.

Cumulative incidence of death for all-cause mortality, COVID-19 mortality and all-cause non-COVID-19 mortality is shown in figures 2 and 3 and online supplemental figure S2, respectively. Corresponding incidence rates are shown in tables 2–4, respectively. All-cause non-COVID-19 mortality was higher among Qataris than among the CMW and urban populations, but COVID-19 mortality was lower among Qataris. COVID-19 mortality among CMWs increased rapidly initially during the first epidemic wave (online supplemental figure S1), but the increase slowed down over time of follow-up (figure 3).

Adjusted HR comparing all-cause mortality relative to Qataris was 0.59 (95% CI 0.53 to 0.66) for the CMW population and 0.74 (95% CI 0.68 to 0.80) for the urban population (table 2). Adjusted HR comparing COVID-19 mortality relative to Qataris was 1.86 (95% CI 1.32 to 2.60) for the CMW population and 1.24 (95% CI 0.96 to 1.61) for the urban population (table 3). Adjusted HR comparing all-cause non-COVID-19 mortality relative to Qataris was 0.51 (95% CI 0.45 to 0.58) for the CMW

Table 3 HRs comparing risk of death for COVID-19 mortality in major nationality groups in Qatar relative to Qataris

Pairwise comparison*	Cohort size	Deaths	Total follow-up time in person-years	Incidence rate of death per 1000 person-years (95% CI)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)†
Bangladeshis versus Qataris						
Bangladeshis	91 282	51	97 020	0.53 (0.40 to 0.69)	3.92 (2.13 to 7.22)	4.00 (2.18 to 7.36)
Qataris	91 282	13	96 980	0.13 (0.08 to 0.23)		
Filipinos versus Qataris						
Filipinos	134 246	46	130 981	0.35 (0.26 to 0.47)	3.54 (1.91 to 6.55)	3.57 (1.93 to 6.61)
Qataris	134 246	13	130 930	0.10 (0.06 to 0.17)		
Indians versus Qataris						
Indians	233 577	46	218 735	0.21 (0.16 to 0.28)	1.53 (0.97 to 2.43)	1.54 (0.97 to 2.44)
Qataris	233 577	30	218 451	0.14 (0.10 to 0.20)		
Nepalese versus Qataris						
Nepalese	81 185	16	85 130	0.19 (0.12 to 0.31)	5.33 (1.55 to 18.30)	5.34 (1.56 to 18.34)
Qataris	81 185	3	85 110	0.04 (0.01 to 0.11)		
CMW population‡ versus Qataris						
CMW population	267 863	96	257 908	0.37 (0.30 to 0.45)	1.85 (1.32 to 2.59)	1.86 (1.32 to 2.60)
Qataris	267 863	52	257 629	0.20 (0.15 to 0.26)		
Urban population‡ versus Qataris						
Urban population	304 380	129	294 500	0.44 (0.37 to 0.52)	1.24 (0.96 to 1.61)	1.24 (0.96 to 1.61)
Qataris	304 380	104	294 206	0.35 (0.29 to 0.43)		

*Cohorts were exact matched one-to-one by sex, 10-year age groups, comorbidity count, testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test.
†Cox regression analysis adjusted for sex, 10-year age groups, comorbidity count, SARS-CoV-2 testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test.
‡CMW population includes Bangladeshis, Indians, Nepalese, Pakistanis and Sri Lankans. Urban population includes all other expatriate nationalities residing in Qatar.
CMW, craft and manual worker.

population and 0.70 (95% CI 0.64 to 0.76) for the urban population (table 4).

Adjusted HRs by 3-month intervals since the start of follow-up suggested a declining trend for all-cause non-COVID-19 mortality, particularly for CMWs (online supplemental figure S3). At all follow-up intervals, adjusted HRs were <1 for both the CMW and urban populations.

DISCUSSION

Risk of death is low in the population of Qatar at ~1 death for every 1000 individuals per year, reflecting the population's young demographic structure,[1 24] and the high Human Development Index of 0.848.[28] However, differences were observed in the risk of death by nationality and socioeconomic population sector. For non-COVID-19 mortality, the risk of death was highest among Qataris and lowest among CMWs and the major expatriate nationality groups that comprise this part of the population (Bangladeshis, Indians and Nepalese). Differences in risk of death were smaller between Qataris and the urban population, perhaps reflecting closer similarity in socioeconomic status. Risk of death for each major nationality group in Qatar was also substantially lower than in the country of origin (table 1).

These findings may be explained by the healthy worker effect.[29 30] CMWs are healthy by recruitment and maintain higher levels of physical activity. CMWs may also have lower levels of comorbidities, such as diabetes and obesity.[31] Meanwhile, Qataris are a typical national population that includes both healthy and unhealthy individuals. Studies also suggest high prevalence of specific comorbidities or risk factors among Qataris, such as diabetes, obesity, hypertension and physical inactivity.[31–36] Deaths due to road injuries may affect Qataris and the urban population more than CMWs. CMWs are unlikely to own cars, but use buses for transportation, unlike Qataris and the urban population who have high socioeconomic status and car ownership ratios. Studies suggest considerable incidence of traffic injuries in Qatar, with higher rates among Qataris.[37–39]

COVID-19 mortality was substantially higher among CMWs than among Qataris and the urban population. CMWs were the most affected population by the first epidemic wave (figure 3),[3–5 9 19 20] before advent of more effective COVID-19 treatments and availability of

Table 4 HRs comparing risk of death for all-cause non-COVID-19 mortality in major nationality groups in Qatar relative to Qataris

Pairwise comparison*	Cohort size	Deaths	Total follow-up time in person-years	Incidence rate of death per 1000 person-years (95% CI)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)†
Bangladeshis versus Qataris						
Bangladeshis	91 282	145	97 020	1.49 (1.27 to 1.76)	0.53 (0.44 to 0.65)	0.53 (0.44 to 0.65)
Qataris	91 282	271	96 980	2.79 (2.48 to 3.15)		
Filipinos versus Qataris						
Filipinos	134 246	131	130 981	1.00 (0.84 to 1.19)	0.56 (0.45 to 0.69)	0.56 (0.45 to 0.69)
Qataris	134 246	235	130 930	1.79 (1.58 to 2.04)		
Indians versus Qataris						
Indians	233 577	199	218 735	0.91 (0.79 to 1.05)	0.38 (0.32 to 0.45)	0.38 (0.32 to 0.44)
Qataris	233 577	523	218 451	2.39 (2.20 to 2.61)		
Nepalese versus Qataris						
Nepalese	81 185	65	85 130	0.76 (0.60 to 0.97)	0.51 (0.38 to 0.68)	0.51 (0.38 to 0.68)
Qataris	81 185	128	85 110	1.50 (1.26 to 1.79)		
CMW population‡ versus Qataris						
CMW population	267 863	412	257 908	1.60 (1.45 to 1.76)	0.52 (0.46 to 0.58)	0.51 (0.45 to 0.58)
Qataris	267 863	798	257 629	3.10 (2.89 to 3.32)		
Urban population‡ versus Qataris						
Urban population	304 380	877	294 500	2.98 (2.79 to 3.18)	0.70 (0.64 to 0.77)	0.70 (0.64 to 0.76)
Qataris	304 380	1248	294 206	4.24 (4.01 to 4.48)		

*Cohorts were exact matched one-to-one by sex, 10-year age groups, comorbidity count, testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test.
†Cox regression analysis adjusted for sex, 10-year age groups, comorbidity count, SARS-CoV-2 testing method (PCR vs rapid antigen testing) and calendar week of the SARS-CoV-2 test.
‡CMW population includes Bangladeshis, Indians, Nepalese, Pakistanis and Sri Lankans. Urban population includes all other expatriate nationalities residing in Qatar.
CMW, craft and manual worker.

vaccines, and thereby at higher risk of COVID-19 death. All subsequent waves occurred in 2021 and thereafter (online supplemental figure S1),[12–16] after onset of the national COVID-19 mass vaccination campaign and coincident with availability of new treatments and improved case management.[17 21 40 41] Although all COVID-19 healthcare, including testing, treatment, vaccination and acute care and intensive care unit hospitalisations, was accessible and provided free of charge equally for citizens and residents in the public healthcare system, lower health awareness among CMWs may have contributed to delays in infection diagnosis and presentation to healthcare facilities, which may have exacerbated risk of COVID-19 death. It remains unknown whether some of the observed differences in risk of COVID-19 death by nationality could be due to unobserved biological or behavioural differences.

Nevertheless, the COVID-19 death rate in Qatar has been one of the lowest worldwide.[42] As of 30 September 2022, six hundred and eighty-two COVID-19 deaths have been recorded in this country; <0.1% of documented infections ended in death. COVID-19 death has been rare, with a cumulative incidence of only two deaths per 10 000 individuals after more than 2 years of follow-up (figure 1). The young age profile of the population, with only 9% being ≥50 years of age, may explain the low COVID-19 mortality.[9 43] The well-resourced universal public healthcare system, which remained below its threshold even during peaks of epidemic waves, may have also contributed to low COVID-19 mortality.[9] Emphasis on broad SARS-CoV-2 testing coupled with proactive, early treatment may also have limited the number of people who required hospitalisation or developed severe or critical disease.[9]

Study findings are not consistent with CMWs in Qatar experiencing an elevated risk of death due to occupational hazards, such as falls in construction sites or working under severe heat stress, as suggested elsewhere.[44] Results of the present study highlight the importance of rigorous control of confounding factors in analysing and comparing mortality rates. For example, incidence rates of COVID-19 death were lowest among Nepalese at only 0.05 per 1000 person-years and highest among Qataris at 0.24 per 1000 person-years (table 1). However, after controlling for differences in sex, age and existing comorbid conditions in matched cohort studies

comparing the various nationality subpopulations, adjusted HRs of COVID-19 death were highest among Nepalese and lowest among Qataris (table 3). Risk of COVID-19 death was 5.34-fold higher among Nepalese than among Qataris, opposite the result of the uncontrolled comparison. For a rigorous understanding of causes of death in Qatar, a national project has recently been initiated to methodologically review and analyse all deaths that occurred in Qatar, whether at healthcare facilities or elsewhere, since 2018. The project aims to provide a fine-grained understanding of causes of death in this country, including those that relate to occupational hazards.

This study has limitations. As an observational study, investigated cohorts were neither blinded nor randomised, so unmeasured or uncontrolled confounding cannot be excluded. The study analysed all deaths that occurred in Qatar since onset of the COVID-19 pandemic, but some deaths may have occurred outside Qatar, while expatriates were abroad, such as when visiting family in home countries. These out-of-Qatar deaths could introduce differential ascertainment bias if their rates differed for non-Qataris versus Qataris. Some expatriates may have left Qatar permanently because of end of employment or other reasons after initiation of follow-up, but travel data were not available for our analysis. With the restrictions on travel and international recruitment of labour during the pandemic, such movements in and out of the country were probably limited in scale in the early phases of the pandemic but increased with time as restrictions were gradually lifted. Mid to end of 2022 (towards the end of this study) in particular was a time during which such migration movements may have increased substantially as more CMWs may have left Qatar with the end of World Cup 2022 construction projects. Such migration movements can bias results due to differential loss of follow-up for non-Qataris versus Qataris, as Qataris are less likely to have permanently left Qatar.

The study investigated mortality during the COVID-19 pandemic, but mortality during the pandemic may have differed from that in earlier years, and may not be representative of incidence of death prior to the pandemic. For instance, occupational injuries may have declined in recent years.[45–47] Public health restrictions imposed during the pandemic may have further reduced deaths due to occupational hazards, in addition to reducing other causes of death, such as road traffic injuries.

These sources of potential bias tend overall to underestimate all-cause non-COVID-19 mortality among non-Qataris, and perhaps more for CMWs. Analysis of non-COVID-19 mortality by time of follow-up appears consistent with an effect for differential ascertainment bias and/or loss of follow-up bias (online supplemental figure S3). However, the analysis also confirmed lower non-COVID-19 mortality for both the CMW and urban populations at all times of follow-up, including times right after recruitment into the cohort, when the effect of such biases is presumed minimal. It also seems unlikely that these sources of bias can fully explain the large observed differences in mortality rates.

The national SARS-CoV-2 testing database provided a sampling frame for the population of Qatar, but this database does not include individuals who had no SARS-CoV-2 test done since the pandemic onset. However, with different testing mandates and large volume of testing, it does not seem likely that any citizen or resident in Qatar has not had at least one SARS-CoV-2 test sometime since the start of the pandemic. The CMW and urban populations were defined based on nationality rather than occupation or socioeconomic indicators. However, nationality is strongly associated with both occupation and socioeconomic status in Qatar.[3–5 9 19] The study estimated documented COVID-19 mortality, but COVID-19 may have also caused excess deaths indirectly,[48] but these could not have been quantified using the present study design.

In conclusion, risk of both COVID-19 and non-COVID-19 deaths was low in Qatar during the pandemic, but there were differences in these risks by nationality and socioeconomic population sector. Risk of COVID-19 death was highest among CMWs and lowest among Qataris, largely reflecting differential exposure to the first epidemic wave, before advent of effective COVID-19 treatments and vaccines. Meanwhile, risk of non-COVID-19 death was highest among Qataris and lowest among CMWs, perhaps reflecting the healthy worker effect.

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