Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

the results of other studies, which reported estimates of about 23·7% for Rasht and 27·5% for Guilan province in April and mid-June, respectively.[5,6] This difference cannot be attributed to the different design and analysis of those studies. Moreover, a SARS-CoV-2 seropositive status seems to be durable (at least up to 8 months after infection)[7] and can probably protect people from reinfection.[8] The alarming (red) status of Rasht during the previous months[9] is not consistent with Poustchi and colleagues' estimated seroprevalence, which is higher than the presumed threshold of COVID-19 herd immunity (50–67%).[10]

Finally, as seroepidemiological studies can affect decisions related to immunisation programmes and pandemic control measures, we believe that the results of Poustchi and colleagues' study should be more carefully interpreted, and we hope for studies with more robust design and analysis.

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Authors' reply

We thank Mahan Ghafari and colleagues and Maryam Nazemipour and colleagues for their comments on our study reporting the seroprevalence of SARS-CoV-2 antibodies in 18 cities of Iran.[1] Our findings of considerable variation in seroprevalence rates by city and high exposure levels in Rasht and Qom are supported by Ghafari and colleagues, as they observed similar trends in province-level excess mortality rates in the same regions.[2] These findings are consistent with a high incidence of COVID-19 in a few cities of northern (eg, Rasht in Gilan province) and central (eg, Qom in Qom province) provinces of Iran (red colour-coded regions), as reported by the Ministry of Health and Medical Education (MoHME) early in the pandemic (April–June, 2020).[2] Furthermore, in the seventh report of MoHME, summarising the results of scattered seroepidemiological studies in Iran, among blood donors the prevalence of anti-SARS-CoV-2 antibodies in Gilan province was 55·0% (95% CI 38·0–71·0),[3] with CIs that overlap with the CIs of our estimate in Rasht (72·6%, 95% CI 53·9–92·8).

Conversely, Nazemipour and colleagues stated that our seroprevalence for Rasht was overestimated.[2,4] Their argument was mainly based on the reported seroprevalence of 23·7% in Gilan province in a study by Shakiba and colleagues[4]—a study with several limitations, including a low participant response rate (31·0%) and inadequate information on test characteristics. Although the test-adjusted estimate for Rasht in our study was high, its crude estimate was 58·6%, representing the effect of test characteristics on assessed prevalence (ie, higher prevalence and lower test sensitivity would result in a higher adjusted estimate). The observed variation in adjusted seroprevalence estimates between different studies is partly related to differences in test characteristics. Hence, in addition to test sensitivity and specificity, providing their CIs could indicate the expected variation in a prevalence estimate. In Shakiba and colleagues' study, the CIs for VivaDiag test performance were not assessed.[4] Therefore, the concern raised by Nazemipour and colleagues that the seroprevalence for Rasht was overestimated and inconsistent with other studies is neither supported by our data nor by other studies.

Since the incidence of COVID-19 in Rasht city remained high during the past few months, Nazemipour and colleagues also stated that our reported 72·6% seroprevalence estimate for Rasht did not follow the presumed threshold for herd immunity. We disagree with this statement as the current evidence on herd immunity and its association with antibody status is still lacking, and a high level of exposure (ie, >50%) is not a sufficient indicator for herd immunity against COVID-19.[5] This assumption requires further investigation and could adversely affect the current applied health regulations and vaccination programmes in the country.

Finally, Nazemipour and colleagues highlighted some points with respect to our analytical approach,

including cluster sampling and intra-class correlation coefficient (ICC) for sample size estimation. As stated in appendix 2 of our Article, our design does not completely follow the cluster sampling method. In cluster sampling, the target population is divided into multiple, randomly selected clusters.[6] However, in our study, medical universities located in capital cities of the provinces with the highest reported number of COVID-19 cases (based on MoHME reports) were contacted and invited to the study. Since limited data on SARS-CoV-2 seroprevalence and ICC were available early in pandemic, we selected conservative estimates (δ=0·05) to maximise the sample size. Besides, as we did stratified analyses by city, the effect of individual cluster (ie, city) for each estimate was not required. However, for the pooled analyses, all estimates (including bootstrap procedures) were weighted by each city's population and the sex–age distribution of the population.

In summary, despite the proposed uncertainties by Nazemipour and colleagues, we believe that our findings should be considered in future infection control measures and vaccination programmes in Iran.

We declare no competing interests.

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