

Author response to: Letter to Editor in Response to Assessment of early and post COVID-19 vaccination antibody response in healthcare workers: a multicentre cross-sectional study on inactivated, mRNA and vector-based vaccines.

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We thank Dr. Brandon Goodwin and his colleagues for their thoughts and insights regarding our paper. They begin their letter by summarizing the key finding of our study [1]. They noted that we use healthcare professionals (HCP's) and healthcare workers (HCW) interchangeably by mistake and emphasized that these terms are not synonymous. The first statement is not correct, since we describe HCP as healthcare personnel, which is different from healthcare professionals in terminology, but similar to HCW [2-4]. The diversity of the participating personnel according to their jobs is detailed in Table 2 of our article [5]. In general, HCW defines as any person serving in a health care setting that is in direct or indirect exposure to patients or their infectious secretions and materials. These personnel are included, but not limited to, nurses and nursing assistants,

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doctors, advanced practice providers, technical staff, and environmental services/maintenance staff. However, as these authors pointed out, we agree that the same phrase should be used in the text. In our study, we didn't analyze the risk of SARS-CoV-2 infection among the participants from different job disciplines and exposure status with the infected patients and their contaminated secretions. However, doing a study to investigate the impact of the HCP's exposure levels and their association with the induced anti-SARS-CoV-2 antibody levels would be informative and valuable. In a similar study in NYC, which occupational measures for 40,329 voluntarily essential health care personnel was done for COVID-19 IgG Antibodies, no significant difference according to job functions was detected, but based on the HCP's self-reports, an association was measured between higher suspicious exposure with the virus and seroprevalence (relative risk, 1.23 [95% CI, 1.18-1.28]; $P < .001$) [6].

In the second point, the authors asked about the low percentages of PCR positivity of HCP after vaccination in the studied population. Our results showed the post-vaccination infection in 3.7% and 5.9% of the individuals after the first and second doses of vaccines, respectively. The infection was significantly lower in HCP who presented higher antibody titres before the vaccination. The results also showed low frequency of hospitalization among the partially and fully vaccinated HCP. The frequency of the infection was confirmed by real-time PCR according to standard protocols for the symptomatic HCP, and as it was pointed out, since COVID-19 can be silent or asymptomatic, a higher frequency of PCR-positivity is predictable at post-vaccination as well as the pre-vaccination periods. According to a study that was done by Armin et al. in our hospital, 29.4% of HCP, as frontline workers, were infected with SARS-CoV-2 in May 2020 and the

infection rate increased rapidly thereafter [7]. We also found a PCR re-positivity rate of 13.7% among the symptomatic HCP who experienced an early confirmed infection before the vaccination during a period of 74-360 days after the first onset [8], which was relatively higher in comparison to the prevalence of reported infection after the vaccination among the symptomatic cases of COVID-19. Accordingly, the reported PCR positivity in the symptomatic HCP after vaccination are not representing the infection rate in the whole population under the study and the general population in Iran. Additionally, similar to other countries, HCP were the first group of individuals who vaccinated against COVID-19 infection in Iran, so the infection rate in this group differs greatly compared with the general population. To have a more accurate estimation of the impact of vaccination on the infection rate of HCP, we need to analyze the occurrence of the infection in both the symptomatic and asymptomatic HCP before and after the vaccination course. This analysis was not possible in our study due to the limited laboratory capacity. At the final point, the authors noted that our findings about the induction of higher antibody levels among the vaccinated HCP with a history of SARS-CoV-2 infection are not novel. Thanks for your point, but please consider that our study was run in 2020, and at that time there were few reports about the impact of the natural infection on humoral immunity and the level of induced neutralizing antibody against SARS-CoV-2 infection. Moreover, it was unclear that are the level of induced antibodies varied depending on the virus variants, brands and types of vaccines, and genetics of the population.

Brandon Goodwin *et al.* make several valuable points regarding the importance of understanding the link between SARS-CoV-2 infection and heterogeneity in the level of the induced antibody in different HCP with different job functions and the infectivity of SARS-CoV-2 in symptomatic and asymptomatic vaccinated HCP. Considering the difference in the brands of Covid-19 vaccines and history of infection, we agree that further longitudinal researches are needed to better understand the impact of vaccination on the incidence of SARS-CoV-2 infection in HCP.

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