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Letter to the Editor

Incidence of tuberculosis infection in healthcare workers in high-risk departments for tuberculosis after universal wearing of KF94 mask during COVID-19 pandemic

Dear Editor,

The previous study reported a decreasing number of TB infection after COVID-19 outbreak in mainland China possibly due to restricted access to hospitals during lockdown.¹ Similarly, Lai et al. reported that decline of TB infection during COVID-19 outbreak in Taiwan due to prevention measures, especially wearing mask.² As COVID-19 has spread worldwide since 2020, our hospital has recommended that all employees wear a Korea Filter 94 (KF94, FFP2-equivalent) mask at all times during work to prevent COVID-19. It is certified by the Korean Ministry of Food and Drug Safety for splash protection and safety. Like the N95 respirator, the KF94 mask has high particle filtration efficiency (PFE) for particles with a size of 0.01–1.0 µm and shows the lowest PFE of 94% for particles with a size of about 0.04 µm.³

Although many studies reported that wearing a mask reduces the transmission and acquisition of respiratory viral infections,^{4,5} there have been limited studies on the effect of wearing masks other than surgical masks or N95 respirators on latent tuberculosis infection (LTBI). We analyzed the interferon-gamma releasing assay (IGRA) results of healthcare workers (HCWs) in high-risk departments for tuberculosis before and after wearing a KF94 mask to determine whether wearing a KF94 mask is effective in reducing the rate of LTBI.

This study compared the proportions of positive IGRA test and conversion of HCWs in high-risk departments for tuberculosis during the two periods (Period 1, 2018–2019, the period before wearing the KF94 mask vs. Period 2, 2020–2021, the period after wearing the KF94 mask at all times) at a 2743-bed tertiary care hospital in Seoul, South Korea. In Period 2, it was recommended to wear a KF94 mask universally, but it was still recommended to wear an N95 respirator for patients with tuberculosis or in whom TB was suspected. The study protocol was approved by the Institutional Review Board of our hospital (2022–1414).

The definition of group 1 and 2 of high-risk departments, methods for IGRA tests, and statistical analysis are shown in [Supplemental materials](#).

A total of 7839 HCWs in high-risk departments for tuberculosis were screened between 2018 and 2021. Of the 7839 HCWs, 400 did not perform the QuantiFERON-TB (QFT) test (241 in period 1 and 159 in period 2). The final 7439 people were analyzed (3505 [47%] in period 1 and 3934 [53%] in period 2).

The median age of HCWs in periods 1 and 2 were not significantly different (32 years; [Interquartile range {IQR}, 27–39] vs. 31 years; [IQR, 27–40]; $P = 0.46$) (Table 1). The percentages of group

1 (47% vs. 45%) and group 2 (53% vs. 55%) in high-risk departments between the two periods showed no significant difference ($P = 0.06$).

The proportions of positive test (9% vs. 2%, $P < 0.001$), conversion (3% vs. 1%, $P < 0.001$), and conversion of QFT value of above 0.7 IU/ml (1% vs. 0.4%, $P < 0.001$) in period 1 were all significantly higher than those in period 2 (Table 1), while the proportion of reversion was not different between two periods (1% vs. 2%, $P = 0.75$). When we performed subgroup analysis stratified by groups 1 and 2, the positive rate, conversion rate, and conversion rate of QFT value of above 0.7 IU/ml were decreased in both groups (Table 2).

There have been limited data on the relationship between mask-wearing and risk of LTBI. We found that the proportions of positive test and conversion of QFT among HCWs in high-risk departments were significantly decreased since HCWs had to wear the KF94 mask at all times during their duties. It could be inferred that wearing the KF94 masks helps prevent infection when exposed to patients with tuberculosis. This finding is consistent with previous studies, which reported that the rate of LTBI was lower among medical staff who wore the N95 respirators regularly than those who did not wear them regularly or not at all.⁶

The N95 respirator and the KF94 mask have a difference in the fitting. The fitting depends on the shape of the earring design. The N95 respirator has a headband design, while the KF94 mask has an ear loop design. The ear loop design is less effective at filtering particles,⁷ and the KF94 mask has a thin part that directly touches the face; therefore, it can be easily lifted with movement. Therefore, the N95 respirator showed a significantly higher particle protection rate than the KF94 mask.⁸ However, the positive rate of the QFT test and conversion rate were decreased even when wearing a mask with not-well-fitting in this study.

There are limitations to this study. First, it is difficult to generalize the findings because the study analyzed the IGRA test results for only HCWs of high-risk departments in a single tertiary hospital in Korea (an intermediate tuberculosis-burden country). Second, the

Table 1
Characteristics of healthcare workers, proportions of positive QuantiFERON test, and conversion in periods 1 and 2.

Variable	Period 1 (n = 3505)	Period 2 (n = 3934)	P value
Age, median years (IQR)	32 (27–39)	31 (27–40)	0.46
Male gender, n (%)	638 (18)	747 (19)	0.38
Department classification, n (%)			0.06
Group 1	1658 (47)	1775 (45)	
Group 2	1847 (53)	2159 (55)	
Positive QFT, n (%)	332 (9)	84 (2)	< 0.001
Conversion, n (%)	96 (3)	38 (1)	< 0.001
Conversion (from negative to QFT value of ≥ 0.7 IU/ml), n (%)	47 (1)	14 (0.4)	< 0.001
Reversion, n (%)	52 (1)	62 (2)	0.75

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Table 2

Subgroup analysis of proportion of positive QuantiFERON test, and conversion in groups 1 and 2.

	Period 1	Period 2	P value
Group 1	n = 1658	n = 1775	
Positive QFT, n (%)	160 (10)	43 (2)	< 0.001
Conversion, n (%)	44 (3)	17 (1)	< 0.001
Conversion (from negative to QFT value of ≥ 0.7 IU/ml), n (%)	21 (1)	7 (0.4)	0.005
Reversion, n (%)	21 (1)	29 (2)	0.37
Group 2	n = 1847	n = 2159	
Positive QFT, n (%)	172 (9)	41 (2)	< 0.001
Conversion, n (%)	52 (3)	21 (1)	< 0.001
Conversion (from negative to QFT value of ≥ 0.7 IU/ml), n (%)	26 (1)	7 (0.3)	< 0.001
Reversion, n (%)	31 (2)	34 (2)	0.80

IGRA test method, QuantiFERON-TB test, was changed from the QuantiFERON-TB Gold In-Tube (QFT-GIT) to QuantiFERON-TB-Gold-Plus (QFT-Plus) during the study period (December 2018). The QFT-Plus has been proven to have higher sensitivity than the QFT-GIT⁹; therefore, additional study is needed to confirm the concordance between the two tests. However, we believe that the changing method of QFT might not affect our results significantly, as the proportions of positive test and conversion of the QFT test decreased in period 2 with the more sensitive test. Third, we analyzed the IGRA test results when a single mask (KF94 mask) was worn. Further research is needed to determine whether there is a significant difference depending on the type of mask worn (N95 respirator vs. KF94 mask). Finally, as the number of national tuberculosis patients decreased recently,¹⁰ the positive rate may have decreased from period 1 to period 2 in some proportion.

In conclusion, after wearing a universal KF94 mask, the rate of LTBI among HCWs in high-risk departments for tuberculosis reduced significantly. These findings suggest that wearing the KF94 mask at all times is helpful in decreasing the risk of tuberculosis infection in HCWs.

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Conflict of interest

The authors declare no conflicts of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.jinf.2023.03.017](https://doi.org/10.1016/j.jinf.2023.03.017).

References

- Xu J, Wang Y, Liu F, Yang H. Changes of tuberculosis infection in mainland China before and after the COVID-19 pandemic. *J Infect* 2023;**86**(2). [154–25].
- Lai CC, Yu WL. The COVID-19 pandemic and tuberculosis in Taiwan. *J Infect* 2020;**81**(2):159–61.
- Park SR, Han J, Yeon YM, Kang NY, Kim E. Effect of face mask on skin characteristics changes during the COVID-19 pandemic. *Ski Res Technol* 2021;**27**(4):554–9.
- Brainard J, Jones NR, Lake IR, Hooper L, Hunter PR. Community use of face masks and similar barriers to prevent respiratory illness such as COVID-19: a rapid scoping review. *Eur Surveill* 2020;**25**(49):2000725.
- Kim MC, Bae S, Kim JY, Park SY, Lim JS, Sung M, et al. Effectiveness of surgical, KF94, and N95 respirator masks in blocking SARS-CoV-2: a controlled comparison in 7 patients. *Infect Dis* 2020;**52**(12):908–12.
- Anwar MM, Ahmed DM, Elareed HR, Abdel-Latif RAR, Sheemy MS, Kamel NM, et al. Screening for latent tuberculosis among healthcare workers in an Egyptian hospital using tuberculin skin test and QuantiFERON-TB gold in-tube test. *India J Occup Environ Med* 2019;**23**(3):106.
- Yang HJ, Yoon H, Kang SY, Lee G, Park JE, Kim T, et al. Respiratory protection effect of ear-loop-type KF94 masks according to the wearing method in COVID-19 pandemic: a randomized, open-label study. *J Korean Med Sci* 2021;**36**(28):1147336.
- Park JJ, Seo YB, Lee J. Fit test for N95 filtering facepiece respirators and KF94 masks for healthcare workers: a prospective single-center simulation study. *J Korean Med Sci* 2021;**36**(21):e140.
- Sotgiu G, Saderi L, Petruccioli E, Aliberti S, Piana A, Petrone L, et al. QuantiFERON TB Gold Plus for the diagnosis of tuberculosis: a systematic review and meta-analysis. *J Infect* 2019;**79**(5):444–53.
- Son E, Jeon D. Current situation of tuberculosis and national strategic plan for tuberculosis control in Korea. *J Korean Med Assoc* 2021;**64**(4):316–23.

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