Short Communication

Non-woven Masks and SARS-CoV-2 Infection in a Cluster Setting in Japan

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ABSTRACT: Evidence regarding the types of masks that are effective in preventing infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is limited. We identified the mask types that were effective against SARS-CoV-2 infection in a cluster setting in Japan. Data from a cluster of employees with coronavirus disease 2019 at a manufacturing company in mid-August 2021 were retrospectively reviewed. A total of 87 employees who reported the type of mask worn were included. The types of masks were dichotomized into non-woven masks or other types of masks, such as cloth or urethane masks. The association between mask type and SARS-CoV-2 infection was determined using logistic regression analysis after adjusting for potential confounders. Participants who wore non-woven masks were less likely to be infected with SARS-CoV-2 (9.7%) than those who wore other types of masks (26.7%). After adjusting for potential confounders, wearing a non-woven mask was significantly associated with a reduced risk of infection compared to wearing other types of masks (odds ratio, 0.10; 95% confidence interval, 0.01–0.80). Non-woven masks were more effective in preventing SARS-CoV-2 infection in a cluster setting than other types of masks, such as cloth or urethane masks.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the cause of coronavirus disease 2019 (COVID-19), has spread worldwide (1–3). Several methods have been recommended to prevent infection with SARS-CoV-2, including wearing a mask, hand hygiene, avoiding crowds or enclosed and poorly ventilated spaces, and vaccination (2–9). One of the most important preventive measures against SARS-CoV-2 infection is wearing a mask (10,11). At least two factors must be considered regarding mask wearing: the type and fit of the mask (2,7,12,13). Although the requirement to use a mask that is a correct fit is clear, the importance of the type of mask has rarely been investigated (13), except in aerodynamic simulations. Therefore, we examined which types of masks, non-woven or others, were effective in preventing SARS-CoV-2 infection in a cluster setting at one company in Japan.

This was a retrospective cohort study of a cluster of COVID-19 cases that occurred in an electronics manufacturing company in Okayama Prefecture,

western Japan.

In mid-August 2021, the first cluster of infections occurred during the fifth wave of the COVID-19 outbreak in Japan, when the Delta variant was prevalent. Ultimately, 13 infected employees were identified in the cluster over three weeks. The company is located in a two-story building with the assembly line on the first floor and the administration department, cafeteria, and part of the assembly line on the second floor. The working area in the assembly line is divided into areas for each type of work, by work tables; however, each area was not separated by walls and connected in one space on both floors. In the cafeteria, each employee had a designated location to sit, facing in the same direction. Smoking areas were located outdoors in well-ventilated areas and were available to only one person at a time. All 92 employees wore masks at work, but the type of mask varied and the ventilation conditions were poor.

After three employees were infected, the public health center began an investigation into the company. Moreover, the public health center conducted a detailed follow-up survey of all employees one month after the first COVID-19 case was identified. The center administered a questionnaire and inquired about the type of mask worn at work, vaccination status, age, sex, working environment, and other demographic information of the employees. A total of 89 employees returned the questionnaire. Of these, two who did not report the type of mask were excluded. Therefore, data

Table 1. Demographic characteristics of employees (*N* = 87)

	Mask type	
	Non-woven type (*n* = 72)	Other types (*n* = 15)
Age, *n* (%)		
<30	14 (20)	2 (13.3)
30–39	27 (38.6)	5 (33.3)
≥40	29 (41.4)	8 (53.3)
Sex, *n* (%)		
Male	21 (29.2)	11 (73.3)
Vaccinated status		
Fully-vaccinated status	26 (36.1)	4 (26.7)
Working floor, *n* (%)		
First floor	46 (64.8)	11 (73.3)
Second floor	25 (35.2)	4 (26.7)
Desk Fan, *n* (%)		
Using desk fan	24 (34.3)	4 (33.3)
SARS-CoV-2 infection cases, *n* (%)	7 (9.7)	4 (26.7)

Desk fan is missing for 3 participants among "Other types" group and 2 participants among "Non-woven type" group. Age is missing for 2 participants among "Non-woven type" group. Working floor is missing for 1 participant among "Non-woven type" group.
SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

from 87 participants were analyzed.

The main focus was on the types of masks worn, particularly non-woven masks. In a questionnaire administered during the follow-up survey, the public health center asked participants the following question: "What type of mask did you wear while engaging in your work in mid-August?" The participants were asked to choose from one of the following options: non-woven mask, cloth mask, urethane mask, or other type of mask. The responses were dichotomized into non-woven masks and other types of masks.

The outcome was defined as a positive polymerase chain reaction (PCR) test for SARS-CoV-2 for an employee of the manufacturing company over a period of three weeks after the first infection occurred. The PCR test was performed for employees who had an onset of symptoms or close contact with infected employees. The collected information was based on active epidemiological investigation data for patients with COVID-19 in the Okayama Prefecture and the public health center. The data was confirmed using information obtained from the company.

After conducting a descriptive analysis, the association between the type of mask worn and infection with SARS-CoV-2 was examined using logistic regression analysis (14). The odds ratios (ORs) for infection with 95% confidence intervals (CIs) were determine using employees who wore other types of masks as a reference. First, a crude analysis was performed and then adjusted for age, sex, and use of tabletop fans (as an indicator of poor ventilation).

In additional analyses, participants were restricted to only those who were unvaccinated because none of the vaccinated participants were infected with SARS-CoV-2. Those who had been vaccinated more than two weeks prior to the second dose of the vaccine (i.e., BNT162b2 or mRNA-1273) were defined as fully vaccinated and those without a fully vaccinated status as unvaccinated. The CIs for infection with 95% CIs were re-estimated to determine the association between the type of mask worn and infection.

All analyses were performed using Stata SE version 17 (StataCorp LLC, College Station, TX, USA). This study was approved by the Institutional Review Board of Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences (2107-025) and was conducted in compliance with the relevant laws and guidelines and with the ethical standards of the Declaration of Helsinki.

A total of 72 participants (82.8%) used a non-woven mask (Table 1). The participants who wore other types of masks tended to be male. Eleven of the 87 participants (12.6%) were positive in the PCR test and all were assembly line workers. The participants who were positive did not use common areas, such as smoking areas or cafeterias, in the two weeks prior to the onset of illness. Among the fully vaccinated participants, none were positive.

The results of the logistic regression analysis are presented in Table 2. Participants who wore non-woven masks were less likely to be infected with SARS-CoV-2 (9.7%) than those who wore other types of masks (26.7%). After adjusting for potential confounders, essentially the same pattern was observed, with an OR for infection of 0.10 (95% CI, 0.01–0.80).

For unvaccinated participants only, the OR of 0.13 (95% CI, 0.02–1.06) was similar (Table 3).

The present findings are consistent with those of a previous study that demonstrated differences in the effectiveness of washable cloth masks and non-woven

Table 2. Association between mask type and SARS-CoV-2 infection ($N = 87$)

	Positive case/number of employees (%)	OR (95% CI)	
		Crude model ($n = 87$)	Adjusted model[1] ($n = 79$)
Mask type			
Other types	4/15 (26.7)	1 (ref)	1 (ref)
Non-woven type	7/72 (9.7)	0.3 (0.07 to 1.18)	0.1 (0.01 to 0.8)

[1]: Adjusted for age, sex, and use of tabletop fans. We categorized age into three groups (under 30 years; 30–39 years; and over 40 years).

CI, confidence interval; OR, odds ratio; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Table 3. Association between mask type and SARS-CoV-2 infection in unvaccinated[1] employees ($n = 57$)

	Positive case/number of employees (%)	OR (95% CI)	
		Crude model ($n = 57$)	Adjusted model[2] ($n = 54$)
Mask type			
Other types	4/11 (36.4)	1 (ref)	1 (ref)
Non-woven type	7/46 (15.2)	0.31 (0.07 to 1.36)	0.13 (0.02 to 1.06)

[1]: We defined those who had been vaccinated more than 2 weeks ago since the second dose of vaccine (i.e., BNT162b2 or mRNA-1273) as fully-vaccinated and those other than fully-vaccinated status as unvaccinated.

[2]: Adjusted for age, sex, and fan use. We categorized age into three groups (under 30 years; 30–39 years; and over 40 years).

CI, confidence interval; OR, odds ratio; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

masks (i.e., surgical masks) in preventing seasonal respiratory viral infections in medical settings (13,15). The present study provides further evidence for the effectiveness of non-woven masks in preventing SARS-CoV-2 infection in general settings. The differences in effectiveness between non-woven masks and other types of masks may be due to the fit and material of the mask as well as appropriate reuse.

This study had several strengths. The possibility of outcome misclassification was reduced because all tests were PCR tests and were performed under the guidance of the public health center. Moreover, the response rate to the questionnaire was high (96.7%), which reduced the possibility of selection bias.

The present study has limitations. First, the public health center asked participants about underlying medical conditions, such as obesity, but it was not possible to assess residual confounding due to obesity because there were many missing responses for this variable. Moreover, information on hand hygiene was not obtained. Due to privacy issues, the date of infection was not provided; thus, an epidemic curve of the cluster could not be generated. Second, there were no cases of COVID-19 among those who were fully vaccinated (i.e., completed two doses of the vaccine); therefore, the effectiveness of non-woven masks among vaccinated individuals could not be assessed. Third, although all infected participants in this cluster would have been infected due to transmission within the company, there is a possibility that some participants were infected from an external source (e.g., at home). Finally, as the present evaluation was conducted in a single-cluster setting, additional studies in other cluster settings are required.

In the present study, non-woven masks were more effective in preventing SARS-CoV-2 infection in a cluster setting than other types of masks such as cloth or urethane masks.

REFERENCES

1. World Health Organization (WHO). Coronavirus (COVID-19) dashboard. Available at <https://covid19.who.int/table>. Accessed February 1, 2023.
2. Chu DK, Akl EA, Duda S, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. Lancet. 2020;395:1973-1987.
3. Center of Disease Control and Prevention (CDC). How COVID-19 spreads. Available at <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html>. Accessed March 20, 2022.
4. Chiu YJ, Chiang JH, Fu CW, et al. Analysis of COVID-19 prevention and treatment in Taiwan. Biomedicine (Taipei). 2021;11:1-18.
5. Piscitelli P, Miani A, Setti L, et al. The role of outdoor and indoor air quality in the spread of SARS-CoV-2: overview and recommendations by the research group on COVID-19 and particulate matter (RESCOP commission). Environ Res. 2022;211:113038.
6. Tharayil A, Rajakumari R, Mozetic M, et al. Contact transmission

of SARS-CoV-2 on fomite surfaces: surface survival and risk reduction. Interface Focus. 2021;12:20210042.

7. Brooks JT, Butler JC, Redfield RR. Universal masking to prevent SARS-CoV-2 transmission-the time is now. JAMA. 2020;324:635-637.

8. Matsuo R, Matsumoto N, Kadowaki T, et al. Effect of mRNA vaccines in preventing COVID-19 severe pneumonia among COVID-19 patients in Japan. J Epidemiol. 2022;32:151-152.

9. Lauring AS, Tenforde MW, Chappell JD, et al. Clinical severity of, and effectiveness of mRNA vaccines against, covid-19 from omicron, delta, and alpha SARS-CoV-2 variants in the United States: prospective observational study. BMJ. 2022;376:e069761.

10. Aghili MS, Darvishpoor Kakhki A, Gachkar L, et al. Predictors of contracting COVID-19 in nursing homes: implications for clinical practice. J Adv Nurs. 2022;78:2799-2806.

11. Aiello AE, Murray GF, Perez V, et al. Mask use, hand hygiene, and seasonal influenza-like illness among young adults: a randomized intervention trial. J Infect Dis. 2010;201:491-498.

12. Brooks JT, Beezhold DH, Noti JD, et al. Maximizing fit for cloth and medical procedure masks to improve performance and reduce SARS-CoV-2 transmission and exposure, 2021. MMWR Morb Mortal Wkly Rep. 2021;70:254-257.

13. Macintyre CR, Seale H, Dung TC, et al. A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. BMJ Open. 2015;5:e006577.

14. Kleinbaum DG, Klein M. Logistic Regression : a Self-Learning Text. 3rd ed. New York: Springer; 2010.

15. Qaseem A, Etxeandia-Ikobaltzeta I, Yost J, et al. Use of N95, surgical, and cloth masks to prevent COVID-19 in health care and community settings: living practice points from the American college of physicians (Version 1). Ann Intern Med. 2020;173:642-649.