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Authors

Boxrud, Cynthia
Householder, Nicholas
Kim, Dylan
et al.

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Inferior altitudinal visual loss and mask-wearing practices: A case series

Cynthia A Boxrud, Nicholas A Householder[1], Dylan K Kim[1], Katherine M Kugler[1], Chandler S Harris[1], Brooke P Benjamin[1], Alexa H Panrudkevich[1], Gavin G Bahadur

Face mask-wearing practices and their impact on the visual field bear particular importance in the coronavirus disease 2019 (COVID-19) pandemic era. This case series examines 10 participants with no history of ocular impairment or visual field defects who underwent age-corrected visual field testing in both eyes with different types of face masks. Wearing duckbill N95 masks was consistently associated with increased accuracy errors in the inferior altitudinal visual field when compared to wearing surgical masks or no masks. These findings support public health guidance that has previously attributed the risks of falls and accidents to face mask wearing.

Key words: Mask, ophthalmology, visual field

Face mask wearing (FMW) has been demonstrated to be an effective practice in populations for limiting the transmission of airborne infectious diseases and has become more common via mask mandates and public health recommendations in many countries, such as the UK, India, and South Korea, since the arrival of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in 2019.[1-3] This case series explores this finding and assesses the association of FMW with the occurrence of inferior altitudinal visual field defects in participants with no known history of ocular conditions.

Case Series

Ten cases underwent visual field testing in both eyes using an age-corrected Peripheral 60 Point Suprathreshold Test on a Humphrey Visual Field Analyzer 3 (ZEISS, Oberkochen, Germany). Participants' age ranged from 22 to 70 years, with a mean (standard deviation [SD]) of 30.2 (17) years. No subjects possessed known histories of ocular disease or existing visual field defects. All participants repeated visual field testing with three categories of facial coverings: no mask, three-ply surgical mask, and duckbill N95 mask [Fig. 1a–c]. All masks were securely positioned on the face of each participant. Sixty targets were presented to each eye for each patient. Errors below the midline of the visual field were recorded and were measured by four metrics. The primary outcome was identified as accuracy errors (unidentified targets), and secondary outcomes were identified as fixation losses (response to previously selected blind spots), false positives (responses to no presentation of targets), and false negatives (failure to respond to a target identified earlier). Accuracy errors were also stratified by distance from the center of the visual field: among the five concentric regions of the visual field visualization, targets were presented in only the third, fourth, and fifth (furthest) rings [Fig. 1d]. Both total and distance-stratified datasets of errors were compared and cross analyzed via two-tailed, paired-subjects *t*-tests in three groups: no mask versus three-ply surgical mask, no mask versus duckbill N95 mask, and three-ply surgical mask versus duckbill N95 mask ($\alpha = 0.05$). Patients provided informed consent for the study as well as for the publication of associated images.

The average accuracy error was 6.3% (95% confidence interval [CI]: 3.6–8.9) when not wearing a face mask, 5.2% (95% CI: 3.3–7.1) when wearing a three-ply surgical mask, and 9.5% (95% CI: 6.4–12.6) when wearing a duckbill N95 mask. Under all three conditions, most accuracy errors (88%, 94%, and 90% of all accuracy errors for no mask, surgical mask, and N95, respectively) were located in the fifth and furthest concentric region of the visual field visualization.

Accuracy errors were consistently associated with duckbill N95 mask wearing. When such errors were aggregated across all participants, the probability of producing an error when wearing a duckbill N95 mask was 1.61 times the probability when wearing surgical masks (95% CI: 1.04–2.49, $P = 0.01$) and 1.57 times the probability when wearing no masks (95% CI: 1.04–2.37, $P = 0.08$); there was no such relationship of visual field obstruction between wearing surgical masks and wearing no masks [Table 1]. Similarly, there were no statistically significant differences in the secondary outcomes of fixation loss, false-positive error, or false-negative error between any two conditions ($P > 0.05$) [Table 1]. When stratified by distance from the center of the visual field, the accuracy errors were significantly concentrated in the fifth and furthest ring; when aggregated across all mask types,

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Jules Stein Eye Institute, UCLA David Geffen School of Medicine, Los Angeles, Ca, USA, [1]Private Practice, Santa Monica, Ca, USA

Correspondence to: Dr. Cynthia A Boxrud, 2021 Santa Monica Blvd. Suite 700E, Santa Monica - 90404, CA. E-mail: boxrud@jsei.ucla.edu

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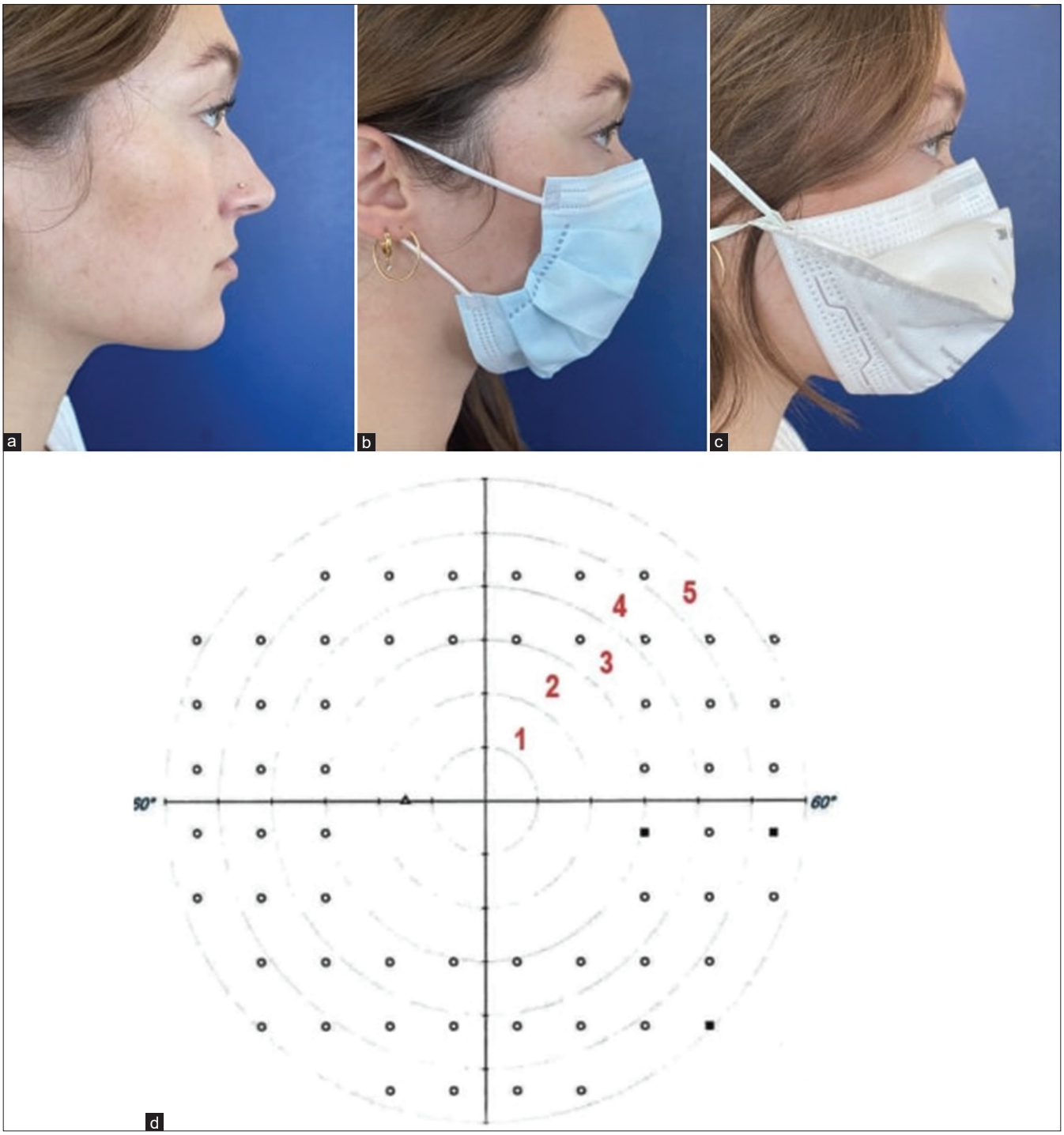

Figure 1: Photographs of mask types and example of visual field exam result. (a–c) Three conditions of mask wearing were investigated: no mask, three-ply surgical mask, and duckbill N95 mask. (d) Exam results were described as targets within five concentric regions (marked by numbers) from the center of the visual field. Accuracy errors are marked as squares

the probability of the occurrence of errors in this region in total sample data was 13.29 times the probability of errors in the third ring of visual field (95% CI: 5.81–30.43, $P < 0.001$). The correlation between wearing N95 masks and obstruction of the visual field was preserved only at this most extreme region (surgical vs. N95: odds ratio [OR]: 1.87, 95% CI: 1.16–2.99, $P < 0.01$; no mask vs. N95: OR: 1.63, 95% CI: 1.03–2.58, $P < 0.05$) [Table 2].

Discussion

Due to the persistence of SARS-CoV-2 and the recent increased presence of its Omicron variant, FMW remains a relevant subject of interest and study. Beyond the pandemic, FMW also presents a pragmatic public health strategy for other issues such as protection against other acute respiratory infections and harmful particulate matter in regions with high

Table 1: Comparison of occurrence of visual field errors with different mask-wearing practices

	Comparison of mask-wearing practices OR (95% CI, *P*)		
	No mask versus three-ply mask	Three-ply mask versus N95	No mask versus N95
Accuracy error	0.98 (0.61-1.57, *P*=0.46)	1.61 (1.04-2.49, *P*=0.01)	1.56 (1.04-2.37, *P*=0.08)
Fixation error	0.86 (0.39-1.93, *P*=0.74)	0.71 (0.29-1.72, *P*=0.63)	0.61 (0.26-1.45, *P*=0.41)
False positive	0.32 (0.06-1.64, *P*=0.34)	1.44 (0.24-8.76, *P*=0.73)	0.47 (0.11-1.91, *P*=0.17)
False negative	1.56 (0.25-9.50, *P*=0.34)	1.91 (0.47-7.83, *P*=0.27)	2.97 (0.59-15.05, *P*=0.1)

CI=confidence interval, OR=odds ratio

Table 2: Accuracy errors stratified by distance from the center of the visual field

	Comparison of mask-wearing practices OR (95% CI, *P*)		
	No mask versus three-ply mask	Three-ply mask versus N95	No mask versus N95
Third ring (closest)	0.11 (0.01-2.03, *P*=0.09)	5.06 (0.24-106.31, *P*=0.33)	0.55 (0.12-2.62, *P*=0.54)
Fourth ring	1.68 (0.22-12.80, *P*=0.56)	1.82 (0.38-8.64, *P*=0.64)	3.05 (0.47-19.53, *P*=0.48)
Fifth ring (furthest)	0.87 (0.52-1.46, *P*=0.64)	1.87 (1.16-2.99, *P*=0.01)	1.63 (1.03-2.58, *P*=0.05)

CI=confidence interval, OR=odds ratio

air pollution.[4] Despite their benefits and popularity, FMW practices have been associated with ocular issues; for example, previous studies have associated widespread mask use with an increased incidence of chalazion in 2020, when compared to previous years.[5] Additionally, FMW has been shown to affect the visual field integrities of six suspected glaucoma patients by inducing artifacts that may be confounded with glaucomatous defects.[6,7] These studies have also placed focus on the usage of surgical masks; however, there is no known research that compares visual field integrity in different types of masks. Additionally, the impact of FMW practices on visual integrity in patients with no risk of glaucoma has not been extensively characterized. To resolve these described gaps, this case series examines such correlations with multiple types of masks in cases with no known eye conditions.

Significant obstructions in inferior altitudinal visual fields were associated with duckbill N95 masks and not three-ply surgical masks. This discrepancy reinforces findings from previous studies, which reported that significant disturbances in visual field integrity from surgical masks were resolved after secure attachment of the masks to the face and nose of the patients.[6,7] Similarly, three-ply surgical masks firmly positioned on the face of each participant did not display evident visual obstruction. Such effects support the importance of proper mask wearing not only for the prevention of pathogen transmission, but also for preventing secondary visual impairment.

Regarding public health guidance, there exists suggestions that face masks can obstruct lower peripheral vision and increase the risk of falls or other accidents.[8] The presence of statistically significant differences in inferior altitudinal visual fields with, particularly, duckbill N95 masks provides evidence for this attribution of hazards to FMW. Notably, visual field integrity was altered with FMW only at the extreme limit of peripheral vision; as a result, daily activities that incorporate this range of vision, like reading, walking on stairs, or even driving, should be approached with caution when wearing duckbill N95 masks.[9,10] Because of a relatively small sample size and skewed distribution of participant ages, the impact of other factors like age and original visual acuity could not be analyzed in this case series. Further research should investigate these relationships and examine the potential differences in inferior visual field defects between proper mask wearing and improper mask wearing. Future results will also be strengthened by the inclusion of a larger sample size.

Conclusion

Our results indicate that significant obstructions in inferior altitudinal visual fields are associated with duckbill N95 masks and not three-ply surgical masks, and thus support the public health guidance that has attributed the risks of falls and accidents to improper face mask wearing.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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