

Effect of Surgical Masks and N95 Respirators on Anxiety

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Purpose: Masks are designed to reduce the spread of airborne pathogens, such as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), although wearing a mask has some adverse effects. The primary objective of this study was to explore the effects of surgical masks and N95 respirators on patients diagnosed with anxiety.

Methods: Subjects diagnosed with first-episode anxiety disorders were recruited from outpatient departments between February and July, 2023. A self-administered questionnaire was administered at baseline and at follow-up. The questionnaire addressed demographic information, Hamilton Anxiety Rating Scale (HAM-A), Hamilton Depression Rating Scale (HAM-D) and Insomnia Severity Index (ISI). Subjects were divided into three groups (n=30 each): control (no mask); surgical mask; and N95 respirator. The Kruskal–Wallis test and repeated measures analysis of variance were used to examine associations between face mask use and emotion.

Results: Ninety subjects completed the study, of whom 51 (56.67%) were male and 39 (43.33%) were female. Time and group effects were observed in HAM-A score among the 3 groups. After 4 weeks, mean (\pm SD) HAM-A score decreased from 32.63 \pm 13.37 to 28.07 \pm 9.33 in the control group, increased from 33.67 \pm 12.47 to 36.80 \pm 10.32 in the surgical mask group, and from 32.33 \pm 14.73 to 41.13 \pm 8.29 in the N95 respirator group, with no sex differences among the 3 groups. HAM-A score was significantly higher in the mask groups than that in the control group at follow-up. Only N95 respirator group exhibited significant time effects on HAM-D and ISI scores, with a decreasing trend in HAM-D score and an opposite trend in ISI score.

Conclusion: Prolonged mask use may exacerbate anxiety, especially among those wearing N95 respirator masks. In a post-pandemic environment, governments should improve public health beliefs regarding coronavirus disease 2019 and promote the safety of face mask use, thus reducing the physiological and psychological effects of improper mask use.

Keywords: anxiety, COVID-19, health beliefs, mask, N95

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has increased the global prevalence and burden of mental disorders.¹ Increases in the prevalence of stress, depression, anxiety, and sleep disorders have been reported during the COVID-19 pandemic.^{1,2} On May 5, 2023, the World Health Organization declared COVID-19 a global health emergency.³ Nevertheless, the situation remains uncertain and dynamic. Many countries have enforced compulsory face mask regulations during the COVID-19 outbreak, and a study found that policy stringency was positively associated with face mask use.⁴ According to Google Trends data, online searches for masks is, in large part, positively correlated with the government response stringency index but not new COVID-19 cases per million population.⁵ Currently, countries have reduced their response to the pandemic; however, in April 2023, the Chinese Center for Disease

Control and Prevention issued a new version of mask wearing guidelines.⁶ During the pandemic, the mask mandate further reduced the severity of the situation.

The main modes of transmission for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) include droplets, contact, airborne and fomites.^{7,8} In addition to vaccination and nucleic acid testing, non-pharmaceutical interventions, such as face masks, eye protection, physical distancing, and hand hygiene, are recommended preventive measures for COVID-19.⁹ Wearing masks is an effective measure commonly used by the public to prevent the spread of airborne pathogens, such as SARS-CoV-2,^{9,10} and the most commonly used masks include cloth face masks, surgical masks, and (K)N95 respirator masks.^{5,11}

Medical masks, frequently referred to as “surgical masks”, are designed to prevent the transmission of microorganisms from the wearer to the patient.¹² Filtering facepiece respirators (also termed N95s), certified by the National Institute for Occupational Safety and Health (NIOSH) and cleared by the Food and Drug Administration (FDA), can filter at least 95% of airborne particles.¹³ In contrast, the N95 respirator mask is a higher-level protection mask and is designed to fit tightly, conforming to the wearer’s facial contours.⁹ Laboratory studies have shown that N95 respirator masks exhibit a better blocking effect on infectious viruses than the typical surgical mask.¹⁴ Results comparing the clinical effectiveness of these two types of masks, however, have been inconsistent. Some findings suggest that respirator-type masks may be more effective than surgical masks in preventing infection,¹⁰ while others have found that surgical masks and respirators did not differ in infection risk, which may be related to the fact that respirator use may lead to more adverse events.^{9,12} For example, adjusting a respirator-type mask due to facial discomfort may compromise the seal and increase the risk for infection.

Mask-related adverse effects include headache, shortness of breath, impaired cardiopulmonary exercise capacity, acne, pruritus, earlobe discomfort, vocal fatigue, and discomfort from ocular irritation.^{9,15–18} In addition, face masks that reduce the speed and ability to recognize facial expressions reflecting emotion(s) may lead to misunderstanding and confusion in communication,^{19,20} which in turn increases tension and anxiety. Compared with surgical masks, N95 respirator masks significantly increase the rates of headache, respiratory distress, feelings of discomfort, and psychological influence.^{15,21} One study found that wearing N95 or half-face respirator masks continuously for 3 h/day may produce anxiety in clinical situations.²² A scoping review reported that surgical mask or respirator use may increase anxiety, depression, and psychological distress in both the wearers and those who interact with them.²³

Most of the scientific literature has focused on the effect of the COVID-19 pandemic on mood, not on masks. Earlier studies have evaluated the physiological impact(s) of mask use, but limited research has addressed psychological impact(s), and most have examined healthcare workers. The main objective of the present study, therefore, was to profile and compare the effects of surgical masks, N95 respirator masks, and no masks among subjects diagnosed with anxiety.

Materials and Methods

Study Participants and Data Collection

Subjects were recruited from the outpatient departments of multiple hospitals between February and July 2023. Surgical and N95 masks were selected as the intervention tools because they are the two most widely used medical masks. Subjects in the surgical mask and N95 respirator groups agreed to wear a surgical mask or N95 for 4 h/day when they go out or at work. All subjects were not informed in advance that wearing a mask might affect anxiety. A self-administered questionnaire was administered at baseline and at follow-up (two-week and four-week). A flow-diagram illustrating the study is shown in [Figure 1](#). The questionnaire included questions addressing age, sex, height, weight, educational level, marital status, medical history, and scale assessments. The scales were assessed by two psychiatrists who had received uniform training using a fixed guideline to ensure consistency of scale assessment.

Inclusion and Exclusion Criteria

The diagnostic criteria for anxiety disorders in the International Classification of Diseases, 10th Revision (ICD-10), subjects 18–60 years of age, first episode, junior high school education or above, and Hamilton Anxiety Rating Scale (HAM-A) score > 14. Subjects who fulfilled ICD-10 diagnostic criteria for other psychiatric disorders including

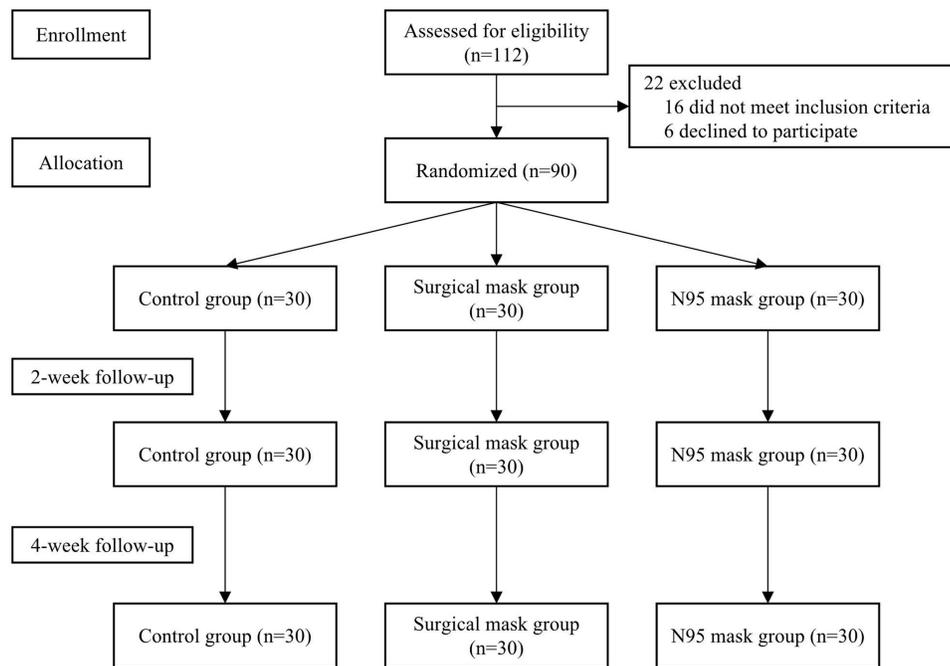


Figure 1 Study flowchart.

schizophrenia, bipolar disorder, alcohol dependence, substance abuse, and organic mental disorders were excluded. In addition, pregnant women, those with diabetes, hypertension, heart disease, acute and chronic respiratory disease, a history of mental disorder(s), or those with frequent changes in the type of masks were also excluded.

Instruments

HAM-A

The HAM-A is an extensively used instrument to assess the severity of anxiety symptoms.²⁴ It consists of 14 items with clinical interview measures of somatic and psychological anxiety symptoms rated on a 5-point Likert scale (scored 0 to 4). The total score ranges from 0 to 56, with higher scores indicating more anxiety symptoms. The internal consistency of the questionnaire was 0.87.

Hamilton Depression Rating Scale

The Hamilton Depression Rating Scale (HAM-D) is a standardized scale used to measure the severity of depressive symptoms.²⁵ The scale contains 17 variables that are measured on either five-point or three-point scales. The total score ranges from 0 to 68, with higher scores indicating more depressive symptoms. In the study sample, the total Cronbach's alpha coefficient for the HAM-D was 0.89.

Insomnia Severity Index

The Insomnia Severity Index (ISI) is a self-reported psychometric questionnaire designed to assess insomnia severity of insomnia.²⁶ It consists of 7 items rated on a 5-point Likert scale. The total score ranges from 0 to 28, with higher scores indicating greater severity of insomnia. A score of 15 to 21 is defined as clinical insomnia (moderate severity). The internal consistency of the ISI was 0.74.

Ethics Approval and Consent

The study design was approved by the Ethics Review Committee of Chaohu Hospital of Anhui Medical University (AnHui, China, KYXM-202301-004), in accordance with the Declaration of Helsinki. The study was registered on the

Chinese Clinical Trial Registry (ChiCTR) website (<www.chictr.org.cn>; ID: ChiCTR2300068020). All subjects provided informed consent and could withdraw from the trial at any time.

Statistical Analysis

Quantitative variables regarding subject characteristics are expressed as mean and standard deviation (SD) and percentages for categorical variables. The Kruskal–Wallis test and repeated measures analysis of variance (ie “ANOVA”) were used to examine the associations between face mask use and emotion. Data were plotted using Prism version 9 (GraphPad Inc., San Diego, CA, USA). All statistical analyses were performed using SPSS version 27 (IBM Corporation, Armonk, NY, USA), and differences with a two-tailed $P < 0.05$ were considered to be statistically significant.

Results

Demographic characteristics of the study population are summarized in Table 1. Ninety participants completed the study: 51 (56.67%) were male and 39 (43.33%) were female. The participants were allocated at a ratio of 1:1:1 to 3 groups (n=30 each): control (no mask); surgical mask; and N95 respirator mask. Subjects ranged in age from 19 to 59 years, with a mean age of 40.64 years. There were no statistically significant differences in demographic characteristics among the 3 groups at baseline.

The relationship between mask use and emotion is illustrated in Figure 2. As shown in Figure 2A, time and group affected HAM-A scores. There was no significant difference in the HAM-A scores among the 3 groups at baseline. At the four-week follow-up, mean HAM-A score decreased from 32.63 ± 13.37 to 28.07 ± 9.33 ($p < 0.001$, $\eta^2 = 0.150$) in the control group, increased from 33.67 ± 12.47 to 36.80 ± 10.32 ($p = 0.071$, $\eta^2 = 0.060$) in the surgical mask group, and from 32.33 ± 14.73 to 41.13 ± 8.29 ($p < 0.001$, $\eta^2 = 0.284$) in the N95 respirator group. HAM-A score was significantly higher in the mask groups than in the control group at both the two-week ($p = 0.012$, $\eta^2 = 0.070$) and four-week ($p < 0.001$, $\eta^2 = 0.232$) follow ups. Results of analysis revealed that anxiety levels in the N95 respirator group increased significantly ($p < 0.001$, $\eta^2 = 0.284$). The effects of mask type on depression and sleep are shown in Figures 2B and C, respectively. Only the N95 respirator had significant time effects on HAM-D and ISI scores, with a decreasing trend for HAM-D score ($p < 0.001$, $\eta^2 = 0.155$) and the opposite for ISI score ($p < 0.001$, $\eta^2 = 0.244$).

The effect of mask use on HAM-A scores for the two sexes is shown in Figure 3. Among males, a time effect was observed in the N95 respirator group. It demonstrated a rising trend for anxiety level ($p = 0.004$, $\eta^2 = 0.206$), and the score was significantly higher than that in the control group at follow-up. Among females, the HAM-A score of the control group was lower at the two-week follow-up than at baseline. It increased in the surgical mask group at follow-up, although the difference was not significant, while it was significantly higher in the N95 respirator group than that in the control group at the four-week follow-up.

Table 1 Demographic Features of All Participants

	Control Group (n=30)	Surgical MASK Group (n=30)	N95 Respirator Group (n=30)	F	P
Age (years)	38.07±10.71	43.23±12.71	40.63±11.29	1.49	0.23
Gender				0.27	0.87
Male	16 (53.33%)	18 (60.00%)	17 (56.67%)		
Female	14 (46.67%)	12 (40.00%)	13 (43.33%)		
Education (years)	12.33±2.82	12.03±2.50	12.40±2.74	0.16	0.85
BMI (kg/m ²)	22.71±3.43	22.97±2.26	23.93±2.82	1.50	0.23
HAM-A	32.63±13.37	33.67±12.47	32.33±14.73	0.08	0.92
HAM-D	12.73±4.45	12.60±4.58	13.60±4.91	0.41	0.67
ISI	14.20±5.24	13.73±5.02	13.77±4.83	0.08	0.92

Abbreviations: BMI, body mass index; HAM-A, Hamilton Anxiety Rating Scale; HAM-D, Hamilton Depression Rating Scale; ISI, Insomnia Severity Index.

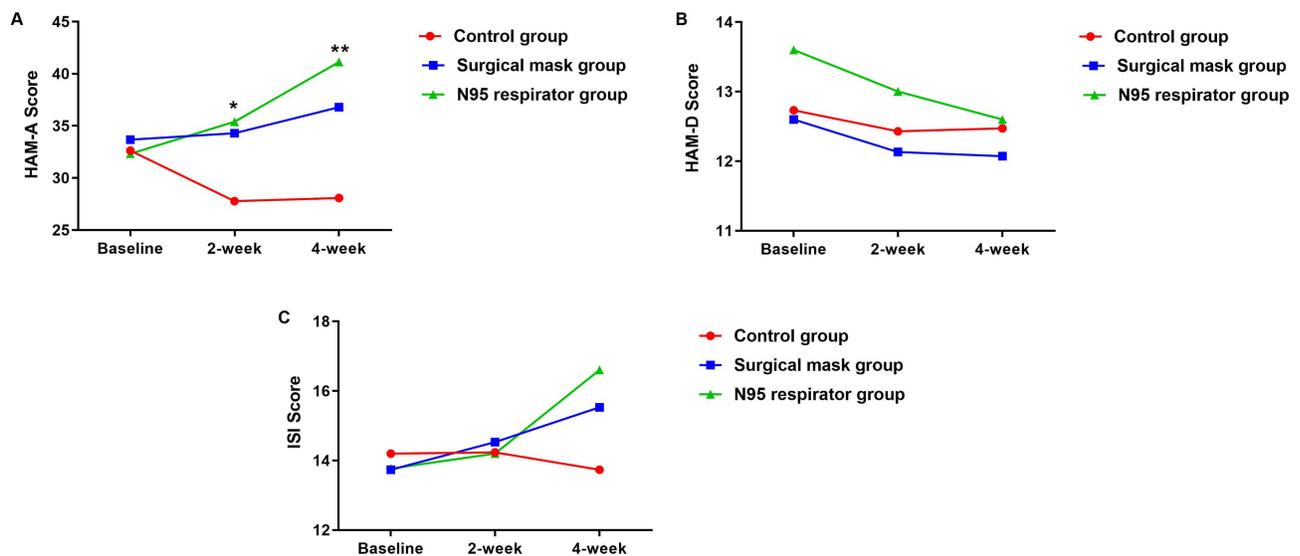


Figure 2 The relationship between mask use and emotion. Mean T scores in HAM-A, HAM-D, ISI are shown, respectively. (A) HAM-A, (B) HAM-D, (C) ISI. Comparison between three groups, * $p < 0.05$, ** $p < 0.01$.

Abbreviations: HAM-A, Hamilton Anxiety Rating Scale; HAM-D, Hamilton Depression Rating Scale; ISI, Insomnia Severity Index.

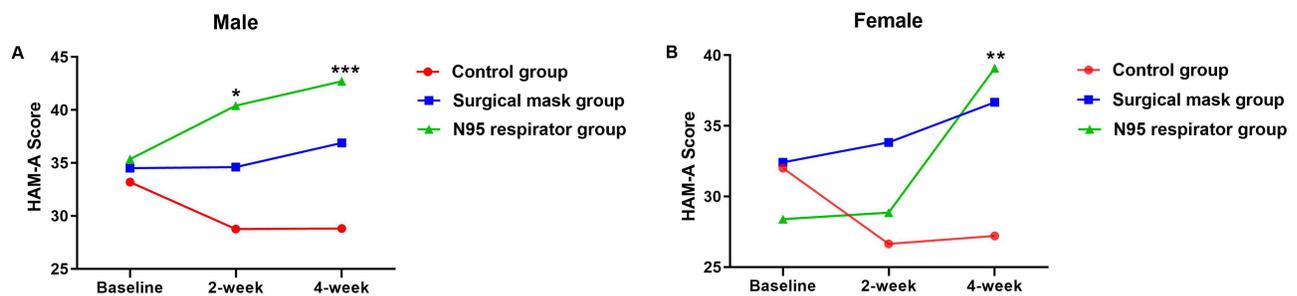


Figure 3 The effect of mask use on HAM-A scores for the two sexes among the three groups. (A) Male, (B) Female. Comparison between three groups, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Abbreviations: HAM-A, Hamilton Anxiety Rating Scale.

Discussion

The present study investigated the effects of long-duration mask use (>4 h daily) on anxiety, depression, and sleep quality, and yielded two key findings. First, wearing surgical masks and N95 respirators was significantly associated with anxiety compared with not wearing a mask, whereas no significant differences were observed for depression or sleep. Second, the N95 respirator had a more severe effect on anxiety than the surgical mask.

Previous studies have found a strong association between sex and COVID-19-related anxiety, with females being more anxious than males.^{27–29} Females are more sensitive to health issues than males, and previous evidence has suggested that females perceive a higher threat and fear of COVID-19 than males, and are more likely to be affected by the social and economic consequences of the pandemic.^{30,31} A study investigating mask preferences found that females were more likely to prefer surgical masks, whereas males preferred cloth masks.¹¹ In South Korea, 82.9% of subjects responded that they would be anxious without wearing a mask,³² the proportion of no anxiety about not wearing a mask was higher among males, and the reasons for anxiety included the risk for droplet transmission of COVID-19, negative public opinion, and the habit of wearing a mask. A total of 41.4% of freelancers reported that they would not wear a mask immediately after the end of the COVID-19 pandemic. Conceivably, individuals with anxiety are more likely to wear masks because they have a strong desire to rid themselves of infection and/or prevent reinfection. The current study

did not find a sex-based difference in the effect of mask use on anxiety, possibly because the subjects were patients diagnosed with anxiety.

A study investigating the psychological influence of wearing different masks for 8 h/day among healthcare workers found no emotional symptoms in the surgical mask group, while there was 1 case of anxiety and 3 cases of depression in the N95 mask group, although these psychological effects were short-term.³³ The work performance of mask wearers was poorer than that of those without masks, and high-anxiety individuals were more affected by mask wearing than low-anxiety individuals.³⁴ Unexpectedly, a possible explanation for the failure of nitrous oxide to produce an analgesic effect in some patients is that masks increase the level of anxiety in children.³⁵ Nevertheless, the relationship between anxiety and masks remains unclear. An exploratory review revealed that mask-wearing may be perceived by individuals with high social anxiety as reducing anxiety, but actually impairs social performance while increasing anxiety.³⁶ Individuals experiencing anxiety often seek to restore their feelings of control using various coping strategies. Some researchers have found that anxiety about COVID-19 was positively associated with the propensity to wear a mask during the pandemic and that the degree of mask wearing mediated the relationship between anxiety and restored feelings of control.³⁷

Health beliefs about COVID-19 were related to face mask use. Individuals with better knowledge of the disease pandemic and higher perceived self-efficacy to wear masks properly were less likely to report depressive symptoms,³⁸ while older individuals who reused facemasks more clearly exhibited depressive symptoms.³⁹ Personal protective equipment (PPE), including masks, gloves, goggles, face shields, and gowns, is used to reduce exposure to health and safety hazards.²³ A cross-sectional survey found that anxiety and depression symptoms were lower among respondents in whom PPE needs were being met.⁴⁰ A plausible reason why our study did not find a significant effect of wearing a mask on depression is that the government's active propagation of knowledge regarding epidemic prevention and control, continuously optimized mask guidelines and ensured consistent face mask supply, thereby improving individuals' COVID-19 health literacy.

The present study suggests that prolonged use of masks increases anxiety, which may be explained by several potential reasons. The first is a classical conditioning response in which masks have been associated with the pandemic. Face masks can reduce the spread of respiratory diseases, and people were asked to wear masks in public places during the COVID-19 outbreak. Masks provide protection while their presence increase anxiety because of the pairing of masks with an emergency. Next, improper mask wearing practice is associated with the increased risk of anxiety.^{41,42} As the participants were not hospitalized patients, we unable to ensure that the mask groups were wearing masks correctly. Lastly, N95 respirators may show more pronounced side effects than surgical masks.⁹ Physio-metabolic side effects of face-mask wearing, such as hypoxia, may exacerbate anxiety.⁴³

Anxiety and insomnia are mutual risk factors.⁴⁴ Individuals with anxiety often experience sleep disturbances, and insufficient sleep can further exacerbate anxiety.⁴⁵ However, the exact mechanisms that underlie sleep and anxiety remain unclear. In this study, after wearing the N95 respirator for 4 weeks, patients with anxiety reached the level of clinical insomnia, which is consistent with previous research demonstrating that N95 respirators could reduce sleep quality.⁴³ Whether wearing an N95 respirator further increases insomnia by increasing the severity of anxiety or directly is unclear and requires further research.

Accumulating evidence has shown that SARS-CoV-2 infection can lead to long-term sequelae affecting multiple organ systems; this condition is commonly referred to as "long COVID".^{46,47} More specifically, these symptoms included headache(s), fatigue, dyspnea, palpitations, skin rash, muscle pain, anxiety, depression, and sleeplessness. Currently, there are no clear guidelines directing the safe use of masks among individuals with emotional disorders. The survey found that more than one-half of respondents used social media as the main source of information on COVID-19⁴⁸ and information searches on social media were positively correlated with mask use. Findings of the present study can be used to analyze mask use in anxious patients, improve the public's COVID-19-related health beliefs, and adjust mask-wearing recommendations. For example, in concerted efforts by the media, governments may disseminate important information on the effectiveness of face masks and promote the safety of face mask use, thereby reducing the risk for physiological and psychological effects caused by improper mask use.

The present study had some limitations. First, no measures were taken to control the time of the subjects wearing a mask per day because they were recruited from outpatient clinics, although we obtained written consent. Rigorous research design

is needed in the future, such as the use of time management software contributing to the understanding of the true duration of mask wear. Previous studies investigating the effects of masks on emotion(s) have focused on healthcare workers; therefore, investigation of outpatients is meaningful. Second, we did not investigate whether participants were aware that prolonged mask use was associated with mood. If participants believed the mask would make them more anxious, it could have led to a placebo effect. The follow-up study intends to recruit patients with anxiety and randomly divide them into control group and experimental group. Both groups will wear the same type of mask and for the same amount of time, the duration of mask wearing will be standardized and recorded but the experimental group will be told that prolonged use of the mask may aggravate anxiety, to verify the presence of an anti-placebo effect. Third, this study only analyzed the effects of masks on anxiety, and we acknowledge that other predisposing factors, such as stress, personality traits, occupation, climate, and behavioral factors, may also exacerbate anxiety. In addition, participants came from different regions with different epidemic risks, which could also have an impact on anxiety. Further research is needed into the reasons why masks increase anxiety. Finally, the small sample size was a limitation of the present study; as such, more research based on larger samples should be conducted to understand the impact of masks on emotions.

Conclusions

This study showed that compared with not wearing a mask, surgical and N95 respirator masks exacerbated anxiety, especially the N95 respirator. Masks are an effective tool for mitigating the spread of respiratory viruses. In a post-pandemic environment, individuals are encouraged to use appropriate types of masks to ensure comfort and safety, rather than avoiding mask or respirator use. Further research is needed to determine why mask use is associated with greater anxiety, which would be beneficial for governments taking action to promote the safety of face mask use, and thus reduce the risk for physiological and psychological effects caused by the improper use of masks.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent

This study was approved by the ethical review board of Chaohu Hospital of Anhui Medical University (AnHui, China, KYXM-202301-004), which conformed to the principles embodied in the Declaration of Helsinki. Informed consent was obtained from participants involved in the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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