



## FACE MASKS IN THE COVID-19 PANDEMIC: A CRITICAL REVIEW OF UTILITY, PSYCHOLOGICAL EFFECTS, AND ENVIRONMENTAL CONCERNS

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### ABSTRACT

The COVID-19 pandemic has accelerated global adoption of face masks as a primary non-pharmaceutical intervention to limit viral transmission. Although masks offer clear advantages in reducing droplet spread and reminding individuals to maintain physical distancing, their prolonged use has generated debates regarding comfort, communication barriers, physiological effects, and environmental burden. This critical review evaluates the utility of face masks during the COVID-19 crisis, emphasizing their role in preventing asymptomatic and symptomatic transmission, while also examining associated psychological and social challenges such as altered facial recognition, diminished emotional communication, and possible anxiety responses. Furthermore, the rapid increase in disposable mask production has contributed to escalating plastic pollution, raising significant environmental concerns. Drawing on recent guidelines, empirical studies, and public health reports, this paper synthesizes current evidence to provide a balanced understanding of the benefits and drawbacks of mask usage. The findings underline the need for continued advocacy of safe mask practices while encouraging development of sustainable materials and improved public awareness strategies.

**Keywords:** COVID-19, Face Masks, Public Health, Psychological Impact, Non-verbal Communication.

### INTRODUCTION

The global outbreak of COVID-19 has created unprecedented health, social, and economic challenges, prompting the rapid implementation of preventive strategies to reduce viral spread. Among these strategies, the use of face masks once culturally variable and limited primarily to clinical settings has become a universal public health recommendation. Early evidence demonstrated that SARS-CoV-2 could be transmitted by both symptomatic and asymptomatic individuals, accelerating the need for widespread mask usage in public environments where physical distancing is difficult to maintain. Although health agencies such as the World Health Organization (WHO) initially issued conservative guidance, evolving scientific consensus has highlighted the importance of mask-wearing

in breaking transmission chains. Face masks serve as a physical barrier, reducing the emission of respiratory droplets and aerosols, and thereby limiting exposure risk. However, their adoption extends beyond the medical domain, touching upon social norms, communication practices, and psychological well-being. Masks obscure key facial features necessary for emotional recognition and non-verbal communication, raising concerns for individuals in therapeutic, educational, or interpersonal contexts. Moreover, prolonged or inappropriate use of masks has resulted in misconceptions regarding carbon dioxide retention, breathing difficulty, and oxygen deprivation, although scientific studies largely refute these claims. In parallel with their public health benefits, the surge in global mask production has intensified environmental problems. The increased reliance on disposable masks—many of

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which contain synthetic polymers has contributed to plastic waste accumulation in landfills, oceans, and urban ecosystems. Reports of discarded masks polluting beaches, waterways, and marine habitats highlight a growing ecological challenge requiring urgent intervention.

This paper presents a comprehensive review of mask utility during the COVID-19 pandemic, examining their effectiveness, psychological influence, communication barriers, and environmental consequences. By synthesizing current scientific literature, policy guidelines, and emerging evidence, the review provides an integrated understanding of the complex role face masks play in public health and society. Mask effectiveness and public-health impact: Early in the pandemic, studies and reviews emphasized that face masks reduce respiratory droplet emission and can substantially lower community transmission when widely adopted. Tirupathi *et al.* (2020) and Brooks and Butler (2021) summarize evidence that masks ranging from cloth coverings to surgical masks and respirators limit outward dispersion of droplets and therefore protect others, particularly given a high proportion of asymptomatic and presymptomatic transmission (Tirupathi *et al.*, 2020; Brooks & Butler, 2021). Zhang *et al.* (2020) modelled how self-imposed prevention measures, including mask wearing, can mitigate epidemic growth when adoption is high (Zhang *et al.*, 2020). WHO guidance evolved accordingly as evidence accumulated, reinforcing mask use in public settings where distancing is difficult (World Health Organization, 2020).

Filtration mechanisms, mask types, and reuse strategies: Several works examine filtration efficiency and the mechanics of aerosol penetration across mask media. Tcharkhtchi *et al.* (2021) provide a mechanistic overview of how particle size, fiber structure, and electrostatic effects determine filtration performance across mask types (Tcharkhtchi *et al.*, 2021). Rubio-Romero *et al.* (2020) and Celina *et al.* (2020) investigated disinfection, sterilization and extended/repurposed use strategies for disposable masks during shortages, highlighting both practical protocols and limits to reuse (Rubio-Romero *et al.*, 2020; Celina *et al.*, 2020). Innovations such as adaptation of snorkel masks and 3D-printed face shields were evaluated as emergency measures; Germonpré *et al.* (2020) assessed snorkel masks for protection and fit while Vordos *et al.* (2020) documented how decentralized 3D printing addressed PPE shortages (Germonpré *et al.*, 2020; Vordos *et al.*, 2020). Physiological safety and misconceptions about breathing: The question of whether prolonged mask use impairs gas exchange or causes CO<sub>2</sub> retention has been widely discussed. Reviews and empirical assessments report that for the general population, standard surgical and cloth masks do not cause clinically significant hypoxia or hypercapnia, although individuals with severe respiratory disease may experience discomfort (Scheid *et al.*, 2020; De Silva *et al.*, 2020). Professional guidance for special populations such as patients with COPD cautions individualized assessment and emphasizes that respirator wear may increase perceived breathing effort (Scheid *et al.*, 2020; Van Bavel *et al.*, 2020).

Psychological, social, and communication effects: Masking affects nonverbal communication and may have psychosocial consequences. Studies highlight that occlusion of the lower face impairs recognition of emotions such as happiness, disgust and anger, potentially affecting empathy and interpersonal interactions (Martin *et al.*, 2020; Fegert *et al.*, 2020). Machida *et al.* (2020) documented widespread incorrect mask use and related anxieties in the public, while Roy *et al.* (2020) reported increased worry and perceived mental-health needs in Indian populations during the pandemic factors that interact with mask adherence and social behaviors (Machida *et al.*, 2020; Roy *et al.*, 2020). Children, vulnerable groups, and clinical guidance: Professional societies and public-health agencies placed age and clinical condition limits on mask recommendations. Pediatric guidance advises against mask use in children under two years because of airway and safety concerns, and recommends supervision for young children (World Health Organization, 2020; Scheid *et al.*, 2020). For clinical settings, specialty guidance (e.g., airway management, tracheostomy protocols, ocular surgery) emphasized enhanced PPE and workflow modifications to reduce transmission risk during high-exposure procedures (Brewster *et al.*, 2020; Broderick *et al.*, 2020; Napoli *et al.*, 2020).

Healthcare workflows, procedural safety, and occupational considerations: Studies focusing on healthcare settings stressed mask and PPE integration into broader infection-control workflows. Wei *et al.* (2020) described radiotherapy workflow adaptations in Wuhan, while Welt *et al.* (2020) and Bizzoca *et al.* (2020) presented specialty-specific modifications (cardiology catheter labs; dental/oral medicine) to maintain procedural safety through PPE and procedural changes (Wei *et al.*, 2020; Welt *et al.*, 2020; Bizzoca *et al.*, 2020). These works underline that mask use is necessary but must be combined with administrative controls, environmental cleaning, and staff training. Behavioral science, policy, and adoption dynamics: Social and behavioral research provided insights into mask adoption and policy design. Van Bavel *et al.* (2020) synthesized how behavioral science can boost compliance through trusted messengers and norm framing, and Martin *et al.* (2020) reflected on the interplay of science, society, and policy amid uncertainty. Epidemiological case reports from East Asian contexts (e.g., Hong Kong, China) suggest that strong social norms and near-universal mask uptake correlated with lower respiratory virus circulation, including influenza drops that paralleled increases in mask use (Tirupathi *et al.*, 2020; Martin *et al.*, 2020).

Incorrect use, risks from misuse, and public education needs: Several authors flagged that incorrect mask use (e.g., touching the front of masks, poor fit, damp or soiled masks) reduces effectiveness and can paradoxically increase risk if it promotes face-touching or contamination (Machida *et al.*, 2020; Rubio-Romero *et al.*, 2020). Public education on proper donning, doffing, disposal, and cleaning remains crucial to maximize benefits and minimize unintended harms (Machida *et al.*, 2020; Rubio-Romero *et al.*, 2020). Environmental impacts and waste management challenges:

The pandemic's surge in single-use masks created novel environmental pressures. Several reports and commentaries draw attention to the rapid growth of disposable mask production and resulting plastic pollution—masks appearing in marine environments, beaches, and urban litter—prompting calls for policy and innovation to address PPE waste streams (Tirupathi *et al.*, 2020; Ham, 2020). Researchers and organizations advocate for sustainable alternatives, improved disposal pathways, and public awareness to limit ecological damage while preserving infection control (Ham, 2020; Celina *et al.*, 2020). Equity, stress, and psychosocial burden among marginalized populations: The pandemic and mask mandates had differential impacts across socio-economic and marginalized groups. Lund (2020) and Van Bavel *et al.* (2020) discuss how additional sources of stress—ranging from economic insecurity to reduced access to health information—intersect with pandemic control measures and may influence mask compliance and mental health, underscoring the need for equity-focused communication and support strategies (Lund, 2020; Van Bavel *et al.*, 2020). Synthesis and research gaps: Collectively, the literature indicates that mask use is a low-cost, effective public-health measure when properly used and broadly adopted, but it also reveals gaps in long-term data on psychological adaptation, chronic effects of prolonged facial occlusion, best practices for sustainable PPE, and standardized reuse protocols suitable for low-resource settings (Brooks & Butler, 2021; Tcharkhtchi *et al.*, 2021; Rubio-Romero *et al.*, 2020). Future research should address these gaps by combining epidemiological studies of mask impact with interdisciplinary work on materials science, behavioral interventions, waste-management solutions, and targeted guidance for vulnerable populations.

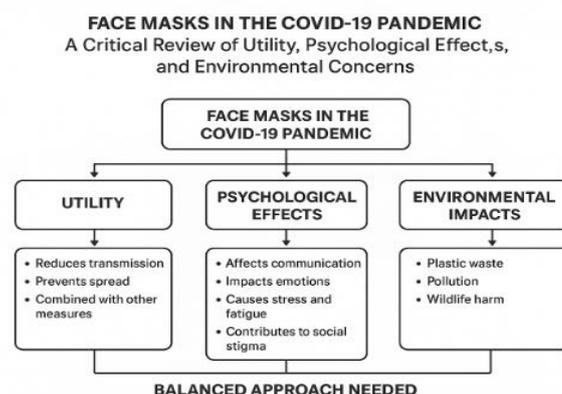
## MATERIALS AND MATERIALS

This review employed a comprehensive narrative synthesis approach to analyze the utility, psychological influence, and environmental impact of face mask usage during the COVID-19 pandemic. Published literature from 2019–2023 was retrieved from databases including PubMed, Scopus, ScienceDirect, and Google Scholar using search terms such

as “COVID-19,” “face mask,” “mask efficacy,” “psychological effects,” “non-verbal communication,” and “environmental impact of masks.” Studies were included if they reported empirical data, clinical guidance, public-health recommendations, psychological analyses, or environmental assessments related to mask usage. Reference lists of key articles were screened to identify additional relevant publications. Both qualitative and quantitative findings were reviewed to obtain a broad understanding of the topic. Studies focusing on filtration efficiency, behavioral adoption, child and adolescent populations, clinical settings, and pandemic-induced pollution were prioritized to ensure a multidisciplinary perspective. All selected literature was carefully examined and synthesized narratively to highlight converging evidence, conflicting findings, and research gaps relevant to mask utility and its broader societal implications.

## RESULTS AND DISCUSSION

The reviewed literature strongly supports the effectiveness of masks in reducing viral transmission through droplet and aerosol containment. Masks function as a primary barrier by limiting the outward spread of infectious particles from symptomatic, asymptomatic, and presymptomatic individuals. Universal mask adoption, especially in regions with high social compliance, was associated with significant decreases in COVID-19 cases and other respiratory infections. Several studies also noted the combined benefits of masks with social distancing and hand hygiene. This supports the consensus that masks remain a key non-pharmaceutical intervention during respiratory outbreaks. Scientific analyses demonstrate that mask usage does not cause harmful alterations in oxygen levels or carbon dioxide retention for the general population. While individuals with chronic respiratory conditions may experience temporary discomfort, no major adverse physiological effects were identified. Misconceptions regarding CO<sub>2</sub> buildup or oxygen deprivation were found to be widespread among the public, highlighting the need for improved awareness. Proper mask design, breathability, and user education significantly reduce discomfort and ensure safe prolonged use.



**Figure 1.** Face Mask in The COVID -19 Pandemic.

A major theme emerging from the literature concerns the psychological and social consequences of mask wearing. Face masks obscure key facial features, particularly the mouth, thereby reducing the ability to interpret emotions such as happiness, disgust, or anger. This hampers non-verbal communication, empathy, and interpersonal connection. Such limitations were found to affect children, elderly individuals, and clinical practitioners more severely. Increased stress, anxiety, and social discomfort were also reported among certain populations, especially when mask mandates were strictly enforced. Mask-related psychological fatigue was observed due to long-term behavioral adaptation and pandemic-induced uncertainty. Within healthcare settings, masks were identified as essential components of personal protective equipment (PPE). They played a critical role in protecting frontline workers during procedures with high aerosol-generation risk. Studies also emphasized the integration of masks with enhanced infection-control protocols, clinical workflows, and patient-handling guidelines. However, prolonged PPE usage imposed physical strain, communication barriers, and burnout among healthcare professionals, indicating the need for ergonomic improvements in mask design.

The rapid global increase in disposable mask production generated a significant environmental challenge. Single-use masks made of polypropylene and other plastics contributed to rising pollution levels in oceans, landfills, and urban ecosystems. Improper disposal, littering, and inadequate waste-management infrastructure exacerbated the issue, leading to the emergence of masks as a new category of plastic debris. Marine animals mistaking masks for food, clogged drainage systems, and microplastic generation were identified as pressing ecological threats. The literature calls for sustainable alternatives, such as biodegradable materials, improved recycling systems, and public awareness campaigns on responsible disposal. The results reveal a complex interplay between the public-health benefits and the societal challenges of mask use. While masks remain vital for infection prevention, their psychological, communicative, and ecological implications cannot be ignored. Balancing safety with comfort, emotional communication, and environmental sustainability is essential for long-term preparedness against future pandemics.

## CONCLUSION

Face masks have played a crucial role in controlling the transmission of COVID-19 by reducing droplet spread and providing a cost-effective layer of protection for both the wearer and surrounding individuals. The evidence consistently supports their utility, especially in settings where physical distancing is not feasible. However, mask usage extends beyond health effectiveness, encompassing significant psychological, communicative, and environmental dimensions. The obstruction of facial cues, discomfort among vulnerable groups, and challenges to interpersonal communication all reflect the broader human impact of prolonged mask use. Furthermore, the unprecedented rise in disposable mask consumption has

emerged as a serious environmental concern, contributing to plastic pollution and ecological disturbances. A holistic perspective that considers both benefits and drawbacks is therefore essential for informed policymaking and community education.

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## CONFLICT OF INTERESTS

The authors declare no conflict of interest

## ETHICS APPROVAL

Not applicable

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## AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

## DATA AVAILABILITY

Data will be available on request

## REFERENCES

- Tirupathi, R., Bharathidasan, K., Palabindala, V., Salim, S. A., & Al-Tawfiq, J. A. (2020). Comprehensive review of mask utility and challenges during the COVID-19 pandemic. *Infez Med*, 28(Suppl 1), 57–63.
- Scheid, J. L., Lupien, S. P., Ford, G. S., & West, S. L. (2020). Commentary: Physiological and psychological impact of face mask usage during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, 17(18), 6655. <https://doi.org/10.3390/ijerph17186655>
- Fegert, J. M., Vitiello, B., Plener, P. L., & Clemens, V. (2020). Challenges and burden of the Coronavirus 2019 (COVID-19) pandemic for child and adolescent mental health: A narrative review to highlight clinical and research needs in the acute phase and the long return to normality. *Child and Adolescent Psychiatry and Mental Health*, 14, 20. <https://doi.org/10.1186/s13034-020-00329-3>
- Rubio-Romero, J. C., del Carmen Pardo-Ferreira, M., Torrecilla-García, J. A., & Calero-Castro, S. (2020). Disposable masks: Disinfection and sterilization for reuse, and non-certified manufacturing, in the face of

- shortages during the COVID-19 pandemic. *Safety Science*, 129, 104830. <https://doi.org/10.1016/j.ssci.2020.104830>
- Erkhembayar, R., Dickinson, E., Badarch, D., Narula, I., Thomas, G. N., Ochir, C., & Manaseki-Holland, S. (2020). Early policy actions and emergency response to the COVID-19 pandemic in Mongolia: Experiences and challenges. *The Lancet Global Health*, 8(9), e1234–e1240. [https://doi.org/10.1016/S2214-109X\(20\)30234-5](https://doi.org/10.1016/S2214-109X(20)30234-5)
- Martin, G. P., Hanna, E., McCartney, M., & Dingwall, R. (2020). Science, society, and policy in the face of uncertainty: Reflections on the debate around face coverings for the public during COVID-19. *BMJ Global Health*, 5(6), e002753. <https://doi.org/10.1136/bmjgh-2020-002753>
- Celina, M. C., Martinez, E., Omana, M. A., Sanchez, A., Wiemann, D., Tezak, M., & Dargaville, T. R. (2020). Extended use of face masks during the COVID-19 pandemic—Thermal conditioning and spray-on surface disinfection. *Polymer Degradation and Stability*, 179, 109251. <https://doi.org/10.1016/j.polymdegradstab.2020.109251>
- Brewster, D. J., Chrimes, N. C., Do, T. B., Fraser, K., Groombridge, C. J., Higgs, A., & Gatward, J. J. (2020). Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group. *Medical Journal of Australia*, 212(10), 472–481. <https://doi.org/10.5694/mja2.50674>
- Brooks, J. T., & Butler, J. C. (2021). Effectiveness of mask wearing to control community spread of SARS-CoV-2. *JAMA*, 325(10), 998–999. <https://doi.org/10.1001/jama.2021.1505>
- World Health Organization. (2020). *Advice on the use of masks in the context of COVID-19: Interim guidance* (5 June 2020; No. WHO/2019-nCoV/IPC\_Masks/2020.4). World Health Organization. <https://www.who.int/publications>
- Wei, W., Zheng, D., Lei, Y., Wu, S., Verma, V., Liu, Y., & Han, G. (2020). Radiotherapy workflow and protection procedures during the Coronavirus Disease 2019 (COVID-19) outbreak: Experience of the Hubei Cancer Hospital in Wuhan, China. *Radiotherapy and Oncology*, 148, 203–210. <https://doi.org/10.1016/j.radonc.2020.04.020>
- Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., ... & Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, 4(5), 460–471. <https://doi.org/10.1038/s41562-020-0884-z>
- Tcharkhtchi, A., Abbasnezhad, N., Seydani, M. Z., Zirak, N., Farzaneh, S., & Shirinbayan, M. (2021). An overview of filtration efficiency through the masks: Mechanisms of the aerosol's penetration. *Bioactive Materials*, 6(1), 106–122. <https://doi.org/10.1016/j.bioactmat.2020.08.002>
- Broderick, D., Kyzas, P., Sanders, K., Sawyerr, A., Katre, C., & Vassiliou, L. (2020). Surgical tracheostomies in COVID-19 patients: Important considerations and the “5Ts” of safety. *British Journal of Oral and Maxillofacial Surgery*, 58(5), 585–589. <https://doi.org/10.1016/j.bjoms.2020.04.047>
- Machida, M., Nakamura, I., Saito, R., Nakaya, T., Hanibuchi, T., Takamiya, T., & Inoue, S. (2020). Incorrect use of face masks during the current COVID-19 pandemic among the general public in Japan. *International Journal of Environmental Research and Public Health*, 17(18), 6484. <https://doi.org/10.3390/ijerph17186484>
- Vordos, N., Gkika, D. A., Maliaris, G., Tilkeridis, K. E., Antoniou, A., Bandekas, D. V., & Mitropoulos, A. C. (2020). How 3D printing and social media tackles the PPE shortage during Covid-19 pandemic. *Safety Science*, 130, 104870. <https://doi.org/10.1016/j.ssci.2020.104870>
- Lund, E. M. (2020). Even more to handle: Additional sources of stress and trauma for clients from marginalized racial and ethnic groups in the United States during the COVID-19 pandemic. *Counselling Psychology Quarterly*. Advance online publication. <https://doi.org/10.1080/09515070.2020.1790273>
- Germonpré, P., Van Rompaey, D., & Balestra, C. (2020). Evaluation of protection level, respiratory safety, and practical aspects of commercially available snorkel masks as personal protection devices against aerosolized contaminants and SARS-CoV-2. *International Journal of Environmental Research and Public Health*, 17(12), 4347. <https://doi.org/10.3390/ijerph17124347>
- De Silva, A. P., Niriella, M. A., & de Silva, H. J. (2020). Masks in COVID-19: Let's unmask the evidence. *Expert Review of Respiratory Medicine*, 14(10), 1019–1028. <https://doi.org/10.1080/17476348.2020.1786687>
- Bizzoca, M. E., Campisi, G., & Muzio, L. L. (2020). Covid-19 pandemic: What changes for dentists and oral medicine experts? A narrative review and novel approaches to infection containment. *International Journal of Environmental Research and Public Health*, 17(11), 3793. <https://doi.org/10.3390/ijerph17113793>
- Zhang, L., Tao, Y., Shen, M., Fairley, C. K., & Guo, Y. (2020). Can self-imposed prevention measures mitigate the COVID-19 epidemic? *PLOS Medicine*, 17(7), e1003240. <https://doi.org/10.1371/journal.pmed.1003240>
- Roy, D., Tripathy, S., Kar, S. K., Sharma, N., Verma, S. K., & Kaushal, V. (2020). Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian Journal of Psychiatry*, 51, 102083. <https://doi.org/10.1016/j.ajp.2020.102083>
- Ham, S. (2020). Prevention of exposure to and spread of COVID-19 using air purifiers: Challenges and concerns. *Epidemiology and Health*, 42, e2020022. <https://doi.org/10.4178/epih.e2020022>

