

Brief Report

Citation: Majeed S, Atapattu PM, Fernando ADA & Wasalathanthri S, 2022. Facemask literacy and usage during the COVID-19 pandemic: A study among employees of the University of Colombo, Sri Lanka during July-August 2021. Sri Lanka Journal of Medicine, pp 77-87
DOI: <http://doi.org/10.4038/sljm.v31i1.319>

Facemask literacy and usage during the COVID-19 pandemic: A study among employees of the University of Colombo, Sri Lanka during July-August 2021

Majeed S, Atapattu PM, Fernando ADA & Wasalathanthri S

Department of Physiology, Faculty of Medicine, University of Colombo, Colombo, Sri Lanka.

Correspondence:

Atapattu PM
Professor
Department of Physiology, Faculty of Medicine,
University of Colombo, Colombo, Sri Lanka
Email : piyushaa@physiol.cmb.ac.lk

 : <https://orcid.org/0000-0002-8252-5446>

Abstract

Background: Correct facemask usage and disposal is crucial to prevent COVID-19 infection spread and environmental pollution.

Objectives: To assess the knowledge and practises on facemask usage among the employees of University of Colombo during the COVID-19 pandemic.

Methods: Web-based, descriptive cross-sectional study was conducted among the employees of University of Colombo using a pre-tested, self-administered questionnaire.

Results: All 208 respondents (female: male=33:19) always wore facemasks outside home. Majority preferred KN-95 (70%)/ surgical masks (64%) over cloth masks (3%). Most (81%) wore double masks, but only 14% practiced double masking as per Centre for disease control and prevention (CDC) recommendation. Only 70% wore facemasks at workplace, 50% inside public transport, 51% at home when outsiders were present and 28% when family members had respiratory symptoms. Removing /lowering facemasks in washrooms (19%), with 1m distancing (7%) or when answering phones (3%) was reported in public places. Main problems included difficulty in breathing (59%), feeling hot (50%), spectacle fogging (42%), and ear pain (42%). Majority disposed facemasks by burning (46%) or with other garbage (38%), highlighting the lack of a proper disposal system. High scores for knowledge (≥ 3) and usage patterns (≥ 4) were found in 93.3% and 68.7% respectively. Females had a higher statistically significant ($p < 0.05$) knowledge on face masks. Correct usage of facemasks was significantly higher ($p < 0.05$) among academics and employees with a higher educational level.

Conclusion: Though the majority adhered to the correct usage of facemasks, some unsatisfactory practises were evident, which require prompt intervention to optimise the desired outcomes. Reinforcing education on the literacy and use of facemasks and developing methods for disposal are immediate necessities.

Keywords: Facemask literacy and usage, COVID-19, University of Colombo



This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY)

INTRODUCTION

In late 2019, a novel coronavirus, the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), emerged in China leading to a global outbreak of coronavirus disease (COVID-19)(1). On 30th January 2020, the World Health Organization (WHO) declared coronavirus disease as a public health emergency of international concern (2). Coronavirus disease consists of a spectrum of clinical manifestations ranging from the common cold to severe acute respiratory syndrome (SARS) (3).

SARS-CoV-2 is transmitted from person to person via multiple mechanisms, including droplet inhalation, contact transmission via mucous membrane and saliva (4). Though vaccination against SARS-CoV-2 is the best means of controlling the COVID-19 pandemic (5), basic measures such as using facemasks, social distancing and regular hand-washing play a major role in the prevention of disease transmission (6).

Though the value of wearing face masks in public was much debated at the onset of the pandemic, there was overwhelming evidence emerging with time on the value of face masks in preventing disease transmission via respiratory droplets. This led the CDC to issue of new guidelines on April 3, 2020, recommending face covers in public preventing virus transmission from the asymptomatic or infected persons (7-9). Moreover, as the majority of asymptomatic infected individuals transmit the infection to others, the use of facemasks assumes a crucial role in the primary prevention of coronavirus transmission among the public (10).

Currently, the main types of facemasks used include cloth masks, medical masks KN95 and N95 masks (11). The degree of protection conferred differ among the different types of masks (8). When comparing their efficacy with individuals wearing no facemasks, median particle emission rate demonstrated a six-fold decrease for surgical (medical) masks or N95 masks although for homemade cotton cloth masks it appeared to be the same or even greater than with no masks (12). The CDC recommendations states that double masking using a surgical mask in combination with a cloth mask worn over it, provides extra protection to the wearer, and reduces the risk of

infection transmission (13). Though wearing facemasks in public is officially recommended, in many instances it is not adhered to (14) and the masks are incorrectly worn below nose or on the chin (15).

Disposable facemasks are made of plastics with polypropylene as the main component (16) and they add hazardous nano and micro plastics to the environment (17). Thus improper disposal of used facemasks will not only promote disease transmission, but will also lead to soil, surface and groundwater pollution (18).

The objectives of the current study were to describe the knowledge, usage patterns and methods of disposal of facemasks among the employees of the University of Colombo and to evaluate the associations between knowledge and usage patterns with selected socio-demographic factors. This target group was selected as it consisted of individuals with diverse socio-demographic backgrounds and educational levels, with access to an official online communication system during a period of restricted mobility. Identifying their knowledge, practices, concerns, misconceptions and reasons for suboptimal adherence to the facemask regulations, would assist in planning and implementing actions to enhance the use of facemasks.

MATERIALS AND METHODS

This web-based cross-sectional study was conducted among the employees of the University of Colombo during July-August 2021. A pre-tested self-administered, anonymised questionnaire as a Google form in English, Sinhala and Tamil was circulated via email through the Network Operations Centre (NOC) of the University of Colombo along with the information sheet and the consent form after obtaining permission from the Vice Chancellor. Ethical clearance was obtained from the Ethics Review Committee, Faculty of Medicine, University of Colombo (EC-21-057). The questionnaire was validated by means of expert validation followed by pretesting among 10 university employees who did not participate in the study. The questionnaire was circulated only once as per NOC policy, and all who consented

were invited to participate. All submitting the completed questionnaire within 2 weeks were recruited to the study.

The questionnaire consisted of items to assess socio-demographic factors, knowledge and usage patterns. The responses used to assess the knowledge and usage patterns are shown in Table1.

Table 1: Responses that were used to assess knowledge and usage patterns

<i>Responses on knowledge about facemasks in preventing transmission of COVID 19 infection</i>
1. Correct technique of wearing a facemask should ensure covering of both nose and the mouth 2. KN-95 and surgical masks are superior to cloth masks 3. Double masking (cloth mask over a medical mask) provides better protection than single masks 4. Masks should be worn even after the majority of population get vaccinated 5. If everyone else wear a mask, then it doesn't matter whether I wear it or not
<i>Responses on usage patterns of facemasks in the usual circumstances</i>
1. I always wear a facemask when going out of the house 2. I wear a facemask when using a public transport 3. I wear a facemask when travelling in a private vehicle with family members/others 4. I wear a facemask at home in the presence of outsiders 5. I wear a facemask at my workplace 6. I wear a facemask at home in the presence of a family member with respiratory symptoms 7. I wear a facemask to prevent COVID-19 transmission to myself from others 8. I wear a facemask to prevent COVID-19 transmission to others from myself
<i>Responses to which additional negative marks were given</i>
1. I remove/lower my facemask when using the washroom at my workplace 2. I remove/lower my facemask when I am answering a phone call at work/ public place/ in a public vehicle 3. I remove/lower my facemask at public places when there's 1m distance between each other

Scores were given for each of the 5 responses assessing knowledge and 8 responses assessing usage pattern as +1 mark for each correct response, -1 mark for incorrect response and the no marks for irrelevant responses. Additional negative marks were given for 4 selected responses assessing usage patterns (Table 1). Total knowledge score was categorized into two groups: Low scores (<3 marks) and high scores (≥3 marks).

Total usage patterns scores were categorized into two groups: low scores (<4 marks) and high scores (≥4 marks). Associations were evaluated for knowledge score vs selected socio-demographic factors, usage pattern score vs selected socio-demographic factors and knowledge score vs usage pattern score.

Statistical Analysis

Data was analyzed using descriptive and comparative analytical tools in SPSS 20.0. Mean and standard deviations were used to describe continuous variables and chi square test and Fisher's exact test were used for evaluating the associations of categorical variables. Statistical significance was set at $p < 0.05$.

RESULTS**Socio-demographic findings**

There were 208 respondents (36.5% males), with a mean ($\pm$ SD) age of 43.00 ($\pm$ 9.75) years. The majority were academics (53.4%), and most were from the medical faculty (37.5%). The socio-demographic characteristics of the sample population are shown in Table 2.

Table 2: Socio-demographic characteristics

Variable	Frequency (%)	
Gender		
Male	76	(36.5)
Female	132	(63.5)
Educational level		
Up to or below A/L	39	(18.8)
Graduate	169	(81.3)
Faculty		
Arts	35	(16.8)
Education	16	(7.7)
Law	11	(5.3)
Management & Finance	17	(8.2)
Medicine	78	(37.5)
Nursing	2	(1.0)
Science	39	(18.8)
Technology	10	(4.8)
Position		
Academic staff	111	(53.4)
Administrative/Financial officer	19	(9.1)
Non-academic staff/ Academic support staff	78	(37.5)

Exploration of knowledge

Knowledge scores of ≥ 3 was found in 93.3% (n=194) of participants. The majority were aware

of the correct technique of wearing facemasks, efficacy of different mask types, double masking and the need for masks despite vaccination status as shown in the Table 3.

Table 3: Frequency and percentage of participants stating the correct response

Variable	Frequency (%)	
Correct technique of wearing a facemask should ensure covering of both nose and the mouth.	208	(100)
KN-95 and surgical masks are superior to cloth masks	191	(92)
Double masking (cloth mask over a medical mask) provides better protection than single masks	158	(76)
Masks should be worn even after the majority of population get vaccinated	168	(81)
If everyone else wears a mask, then it doesn't matter whether I wear it or not	12	(6)

Usage patterns

Usage pattern scores of ≥ 4 was found in 68.7% (n=143) of participants. All participants (100%) always wore facemasks adhering to the correct technique of covering the nose and the mouth when leaving home. The reason stated for this practise among the majority (91%) was to prevent themselves getting infected by the SARS-CoV2 virus. Majority preferred KN-95 masks and 57% practised double masking using KN-95 mask with a

surgical/medical mask. However only 14% practised the accurate double masking as recommended by the CDC, using a cloth mask over a surgical/medical mask. Only 50% wore facemasks when using public transport and up to 20% of participants claimed to remove or lower the facemask when using the washrooms. The facemask preferences, factors influencing the choice of facemasks, instances in which facemask were worn, or removed/lowered are shown in Table 4.

Table 4: Preferences and usage patterns of facemasks

Variable	Frequency (%)	
Preferred type of facemask		
KN-95 mask	145	(70)
Surgical/medical mask	134	(64)
Cloth mask	6	(3)
Factors affecting the choice of the facemask		
Degree of protection		
Comfort	169	(81)
Easy access/availability	73	(35)
Cost	18	(9)
Preferred options for double masking	15	(7)
KN-95 mask with a surgical/medical mask		
KN-95 mask with a cloth mask		
Cloth mask over a surgical/medical mask	119	(57)
Two KN-95 masks	10	(5)
Two medical/surgical masks	29	(14)
Two cloth masks	3	(1)
	38	(18)
Instances of wearing facemasks	0	(0)
When going out of the house		
At the workplace		
At home in the presence of outsiders	205	(99)
When using the public transport	145	(70)
	106	(51)
Instances of removing/lowering facemask	103	(50)
When using the washroom at the workplace		
In public places when there's 1m distance between each other		
When answering a phone call at the workplace/public places /public transport	40	(19)
	14	(7)
When speaking to friends or colleagues	7	(3)
	3	(1)

Problems encountered in utilization and disposal

Multiple problems encountered by wearing facemasks were reported, with the majority complaining of difficulty in breathing (59%) and feeling hot and sweaty (50%). Most disposed the

facemasks by burning (46%) or with municipality garbage disposal (38%). Approximately 1/3rd reused the facemasks after washing. Problems encountered with facemask usage and patterns of disposal and reuse are shown in Table 5.

Table 5: Problems encountered with facemask usage and patterns of disposal and reuse

Variable	Frequency (%)	
Problems encountered		
Difficulty in breathing	123	(59)
Feeling hot & increased sweating	103	(50)
Fogging up of the spectacles	88	(42)
Ear pain	88	(42)
Difficulties in communication	69	(33)
Concerns of environmental pollution by disposed masks	69	(33)
Itchiness	43	(21)
Acne	27	(13)
Patterns of disposal and reuse	95	(46)
Burning	79	(38)
Handing over to municipal council	7	(3)
Burying	74	(36)
Reusing after washing	14	(7)
Reusing without washing		

Associations of knowledge and usage patterns

Evaluating the associations of categorical variables were done using the chi square test. A statistically significant increase in knowledge on facemasks was observed among females compared to males ($p=0.005$). However, knowledge was not significantly associated with age, job position, or educational level.

Facemask usage pattern evaluation revealed that scores for facemask usage pattern was significantly higher among the academics than in the other employee categories ($p=0.014$). A significantly better usage pattern was observed among university graduates compared to non-graduates ($p=0.026$). However no significant association of usage pattern with gender or age was evident. The relationship between the knowledge on facemask and the usage pattern was not statistically

significant. The associations of knowledge and usage patterns are shown in Table 6.

Table 6: Associations between knowledge, usage patterns and selected socio-demographic characteristics

A. Associations of knowledge and socio-demographic factors						
Variable		Knowledge score <3 (n=14) %		Knowledge score ≥3 (n=194) %		P value
Age	<40 years	4	28.6	79	40.7	0.370*
	≥40 years	10	71.4	115	59.3	
Gender	Male	10	71.4	66	34.0	0.005*
	Female	4	28.6	128	66.0	
Educational Level	Graduate	13	92.9	156	80.4	0.476**
	Up to A/L	1	7.1	38	19.6	
Job position	Academic staff	6	42.9	105	54.1	0.199*
	Administrative/Financial officer	0	0.0	19	9.8	
	Non-academic/ Academic support staff	8	57.1	70	36.1	
B. Associations of usage patterns and socio-demographic factors						
Variable		Usage pattern score <4 (n=65) %		Usage pattern score ≥4 (n=143) %		P value
Age	<40 years	24	36.9	59	41.3	0.554
	≥40 years	41	63.1	84	58.7	
Gender	Male	30	46.2	46	32.2	0.052
	Female	35	53.8	97	67.8	
Educational level	Graduate	47	72.3	122	85.3	0.026
	Up to/Below A/L	18	27.7	21	14.7	
Job Position	Academic staff	26	40.0	85	59.4	0.014
	Administrative/Financial officer	10	15.4	9	6.3	
	Non-academic / Academic support staff	29	44.6	49	34.3	
C. Associations of knowledge and usage patterns						
Variable		Usage pattern score <4 (n=65) %		Usage pattern score ≥4 (n=143) %		P value
Knowledge score	Knowledge score <3	7	10.8	7	4.9	0.139**
	Knowledge score ≥3	58	89.2	136	95.1	

*p value was determined using chi-square test, **p value was determined using Fisher's exact test.

DISCUSSION

It was encouraging to note that the majority of participants had high knowledge and usage

pattern scores, which may be attributed to the massive public education campaigns continuing over a year, since the detection of covid-19 is the country. All participants adhered to the CDC

guidelines on facemask use, ensuring a tight/close fit on the face covering both the nose and the mouth (19). This was better than observations in other studies, with 74.7% in Pakistan (20), 78.7% in Nepal (21), 77% in Hawaii (22), 78.4% in Ethiopia (23) and 73.5% in India (24) showing adherence. The majority used KN-95 masks or surgical masks as seen in other studies [20]. This is encouraging as N-95 and surgical masks provide high in-vivo filtration efficiency of 97% and 95% respectively, protecting against aerosol and droplets by filtering particles of size 0.3 μm and 0.04-1.3 μm , respectively (25, 26). The percentage of penetration of cloth masks is higher, making them less efficient (27), though one study in Hawaii revealed that 70% preferred cloth masks (22). The uniform practice of wearing facemasks, especially the highly efficacious ones in the current study appear to be determined by education, comfort, availability and affordability.

CDC recommends wearing double masks, with a cloth mask over a disposable mask considered as the best practice (28). In the current study, the majority (81%) practised double masking, though using a cloth mask over a disposable mask was practiced only by 14%. Similar practice was observed in a study in Vietnam (29). Though CDC recommends not to combine a KN-95 mask with any other mask, and not to wear two medical masks (28), the majority used a N-95 mask with a medical mask, cloth mask or another KN-95 mask or two medical masks (28). However, one study assessing the effectiveness of double masking by systematic quantitative unsteady pressure with flow visualization revealed that double masking with N-95 and surgical masks as well as N-95 and two-layer cotton masks appeared effective with no forward leakage of droplets (30).

The efficacy of facemasks is also determined by their fit and user compliance (27). Majority (81%) stated that masks should be worn even if majority of the population is vaccinated which agrees with the CDC recommendations to wear masks even if vaccinated, to increase protection against the Delta variant (31).

Despite good knowledge, some unfavourable practices were observed. Only 50% used facemasks when using public transport and at home in the presence of outsiders, and up to 20% removed or lowered facemasks in public and 30%

did not wear facemasks at workplace. A large community study in Saudi Arabia revealed similar findings with 87.2%, 80.5%, and 47.5% wearing facemasks in public places, workplaces, or social gatherings respectively (32). An institutional-based Ethiopian study however showed that 61.1% of participants didn't wear masks at public places and only 22.7% wore facemasks always at work (23). The majority (72%) didn't wear masks at home in the presence of family member with respiratory symptoms, though in a cross-sectional study in Hongkong, only 26.9% didn't wear masks when taking care of a family member with respiratory infection (33). It is unclear why despite satisfactory mask literacy, its translation to practice is suboptimal. Removing or lowering facemasks in public is highly discouraged as aerosol particles and very fine droplets can remain suspended in air for minutes to hours (34), and the masks may become contaminated when removing and will increase the risk of infection once re-worn (25).

The main problems identified when wearing masks in the majority (50-59%) were difficulty in breathing and feeling hot as in studies from India and Saudi Arabia (24, 32). Though ensuring better sealing of the mouth and nose, it is harder to breathe when wearing a N-95 mask, unlike a surgical mask (25) or a cloth mask (30) thus providing less comfort. Spectacle-fogging and ear pain were reported by 40%, as in a study from Saudi Arabia (32). Difficulties in communication and maintaining interpersonal relationships were stated by 30%, as found in a survey in India where 4% reported impaired concentration and 53% reported the need to talk louder (24). A study in Texas assessing the effects of transparent facemasks to support verbal communication showed a promising solution to this in that transparent masks provided visual information and assisted in comprehending target sentences (35). Supportive headband may be a solution to ear pain.

Improper facemask disposal causes environmental pollution (18) with polypropylene as the main plastic component of disposable masks (16). About 10 million facemasks are estimated to be released to the environment each month resulting in about 40,000kg of nanoplastics and microplastics imposing health risks (17, 18). In the current study the majority (80%) disposed the used facemasks by

burning or with household garbage collected by the municipality. This highlights the lack of a proper mechanism or policies for the disposal of used facemasks by the general public, inviting environmental pollution as well as possible disease spread especially among garbage collectors. Similar practices have been observed in studies in Morocco (36) and Bangladesh (37). Contaminated waste should be kept in double bags for 72 hours before disposal as the half-life of the virus is 5.6 hours (38) and transported in covered bins inside covered trucks which should be disinfected continuously (39) with all personnel involved wearing personal protective equipment (40). Recycling bins should be kept in public places (41). According to WHO and CDC, masks can be disposed to sanitary landfills (42) and disinfected by UV light (254 nm, 8W, 30 mins), hot air (75°C, 30 mins) and steam (10 mins) (38, 43).

This study revealed that 43% of participants reused facemasks, the majority after washing. However, it was not clear if the masks were multi-use masks, if reused after proper disinfection, or the reason for reusing. Reusing facemasks without washing promote disease transmission and reusing after hand washing may reduce their efficacy (44). Facemask reuse was observed among 96% of healthcare workers in Ethiopia (23), 49% in Japan (45), and 20.2% in Pakistan (20). It has been found that the virus could be killed by exposing it to UVC radiation for 15 minutes and masks can be reused after fumigating with vaporized hydrogen peroxide (25).

Women had significantly higher knowledge scores than males in the present study. Paying greater attention to health education may be a reason for this observation in females. The opposite was seen in a cross-sectional study done in Nepal, which also showed that younger age groups had significantly higher knowledge scores (21). The current study did not show any association of knowledge scores with age or educational level, which implies that health education may have addressed adults of all ages and educational levels. However, significant variation of knowledge with educational level was noted in a study done in Ethiopia (43) as well as Nepal (21).

The present study showed that better-educated participants had significantly higher usage scores as in studies from Japan (45) and Ethiopia (46).

This is expected as better educated persons may have a greater understanding of the value of correct use of facemasks. Though a significant relationship of usage with gender or age was not evident in the current study, significant relationships with gender and age were revealed in studies conducted in Vietnam (47) and Hong Kong (33) respectively. Our study demonstrated no significant relationship between knowledge on facemasks and their use, though it was evident in an Ethiopian cross-sectional study (46). Several factors may have contributed to the observed variations, such as the extent of public awareness programmes, degree of disease spread, policies and regulations of the individual countries.

There are several limitations identified in this study. This was conducted in a selected population of university employees, with official access to online communication. Though this was a heterogenous population from all social strata, the results may not be generalizable. Furthermore, we could officially circulate the invitation to participate only once, which may have limited the number volunteering to participate.

CONCLUSIONS AND RECOMMENDATIONS

In this study, though knowledge and the usage patterns of the majority were found to be generally satisfactory, some unsatisfactory practises in facemask usage were revealed, which requires prompt intervention to optimise mask literacy and practices. Methods to reinforce education on the importance and proper use of facemasks should be developed, and encouraging the proper use of facemasks in practice using incentives and policies should be strengthened. Introducing sustainable methods and national level policies for the disposal of used facemasks are immediate necessities.

Author declaration

Acknowledgements: The authors acknowledge the support of the vice chancellor, registrar and the other administrative officers of university of Colombo for their support and the employees of university of Colombo who consented to participate in this study.

Author contributions: All authors were involved in the initial conception of the study and planning of methodology. Shahana Majeed and Piyusha Atapattu contributed to data collection, analysis and drafted the manuscript. All authors edited and revised the final manuscript.

Conflict of Interests: All authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Sources of funding: None

Statement on ethical clearance obtained and method/s of consent for participation in all studies dealing with human subjects/ material (Consent for participation only in Case reports): Ethical clearance was obtained from the Ethics Review Committee, Faculty of Medicine, University of Colombo (EC-21-057). The participants were recruited after obtaining informed consent.

Statement on Data availability: Data is available on request from corresponding author.

REFERENCES

- Lai C-C, Shih T-P, Ko W-C, Tang H-J, Hsueh P-R. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *International journal of antimicrobial agents*. 2020;55(3):105924.
- Team EE. Note from the editors: World Health Organization declares novel coronavirus (2019-nCoV) sixth public health emergency of international concern. *Eurosurveillance*. 2020;25(5):200131e.
- Yin Y, Wunderink RG. MERS, SARS and other coronaviruses as causes of pneumonia. *Respirology*. 2018;23(2):130-7.
- Peng X, Xu X, Li Y, Cheng L, Zhou X, Ren B. Transmission routes of 2019-nCoV and controls in dental practice. *International journal of oral science*. 2020;12(1):1-6.
- Koirala A, Joo YJ, Khatami A, Chiu C, Britton PN. Vaccines for COVID-19: The current state of play. *Paediatric respiratory reviews*. 2020;35:43-9.
- Alscher L, Weil A, Horwitz R, Stamets P, Chiasson AM, Crocker R, et al. Integrative considerations during the COVID-19 pandemic. *Explore (New York, NY)*. 2020;16(6):354.
- Lyu W, Wehby GL. Community Use Of Face Masks And COVID-19: Evidence From A Natural Experiment Of State Mandates In The US: Study examines impact on COVID-19 growth rates associated with state government mandates requiring face mask use in public. *Health affairs*. 2020;39(8):1419-25.
- Lai A, Poon C, Cheung A. Effectiveness of facemasks to reduce exposure hazards for airborne infections among general populations. *Journal of the Royal Society Interface*. 2012;9(70):938-48.
- Cheng VC-C, Wong S-C, Chuang VW-M, So SY-C, Chen JH-K, Sridhar S, et al. The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. *Journal of Infection*. 2020;81(1):107-14.
- Day M. Covid-19: four fifths of cases are asymptomatic, China figures indicate. *British Medical Journal Publishing Group*; 2020.
- Haq MIU, Khuroo S, Raina A, Khajuria S, Javaid M, Haq MFU, et al. 3D printing for development of medical equipment amidst coronavirus (COVID-19) pandemic—review and advancements. *Research on Biomedical Engineering*. 2020;1-11.
- Asadi S, Cappa CD, Barreda S, Wexler AS, Bouvier NM, Ristenpart WD. Efficacy of masks and face coverings in controlling outward aerosol particle emission from expiratory activities. *Scientific reports*. 2020;10(1):1-13.
- Nalunkuma R, Abila DB, Ssewante N, Kiyimba B, Kigozi E, Kisuzu RK, Kasekende F, Nkalubo J, Kalungi S, Muttamba W, Kiguli S. Double Face Mask Use for COVID-19 Infection Prevention and Control Among Medical Students at Makerere University: A Cross-Section Survey. *Risk Manag Healthc Policy*. 2022;15:111-120
<https://doi.org/10.2147/RMHP.S347972>
- Ganczak M, Pasek O, Duda-Duma Ł, Świstara D, Korzeń M. Use of masks in public places in Poland during SARS-Cov-2 epidemic: a covert observational study. *BMC Public Health*. 2021;21(1):1-10.
- Shelus VS, Frank SC, Lazard AJ, Higgins IC, Pulido M, Richter APC, et al. Motivations and Barriers for the Use of Face Coverings during the COVID-19 Pandemic: Messaging Insights from Focus Groups. *International journal of environmental research and public health*. 2020;17(24):9298.
- Akarsu C, Madenli Ö, Devci EÜ. Characterization of littered face masks in the southeastern part of Turkey. *Environmental Science and Pollution Research*. 2021;1-11.
- Ma J, Chen F, Xu H, Jiang H, Liu J, Li P, et al. Face masks as a source of nanoplastics and microplastics in the environment: Quantification, characterization, and potential for bioaccumulation. *Environmental Pollution*. 2021;288:117748.
- Tripathi A, Tyagi VK, Vivekanand V, Bose P, Suthar S. Challenges, opportunities and progress in solid waste management during COVID-19 pandemic. *Case Studies in Chemical and Environmental Engineering*. 2020;2:10006.
- Prevention CfDca. Wearing a mask www.cdc.gov: Centers for disease control and prevention website; 2021 [updated 30.04.2021]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/easy-to-read/diy-cloth-face-coverings.html>.
- Kumar J, Katto MS, Siddiqui AA, Sahito B, Jamil M, Rasheed N, et al. Knowledge, attitude, and practices of healthcare workers regarding the use of face mask to limit

- the spread of the new coronavirus disease (COVID-19). *cureus*. 2020;12(4).
21. Alam K, Palaian S, Shankar PR, Jha N. General public's knowledge and practices on face mask use during the COVID-19 pandemic: a cross-sectional exploratory survey from Dharan, Nepal. *F1000Research*. 2021;10(376):376.
22. Tamamoto KA, Rousslang ND, Ahn HJ, Better HE, Hong RA. Public Compliance with Face Mask Use in Honolulu and Regional Variation. *Hawaii J Health Soc Welf*. 2020;79(9):268-71.
23. Seid Yimer T, Gebrehana Belay H. Knowledge and Practice of Health Care Providers Towards Proper Face Mask Utilization to Minimize the Extent of COVID-19 Infection in Amhara Region Referral Hospitals, Ethiopia. *Journal of multidisciplinary healthcare*. 2021;14:1583-91.
24. Singh AP, Agrawal P, Gautam A, Kumar D, Garg R, Pursnani N. Knowledge, Attitude, and Practices of Healthcare Workers in Non-COVID Areas of Hospital Regarding the Use of Face Mask to Limit the Spread of the Novel Coronavirus Disease (COVID-19): An Institutional Cross-sectional Online Survey. *Journal of South Asian Federation of Obstetrics and Gynaecology*. 2020;2.
25. Chaudhary G, Chaudhry A, Malik G, Chaudhry N, Kochhar AS, Marya A, et al. Analyzing the Effectiveness and Efficacy of Different Types of Masks and Respirators: A Review. *International Medical Journal*. 2021;28(4).
26. Li Y, Wong T, Chung, Guo Y, Hu J, Guan Y, et al. In vivo protective performance of N95 respirator and surgical facemask. *American journal of industrial medicine*. 2006;49(12):1056-65.
27. Jain M, Kim ST, Xu C, Li H, Rose G. Efficacy and use of cloth masks: a scoping review. *Cureus*. 2020;12(9).
28. prevention CfDca. Improve How Your Mask Protects You Centers for disease control and prevention website 2021 [updated 06.04.2021. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/your-health/effective-masks.html>].
29. Chughtai A, Seale H, Dung TC, Maher L, Nga PT, MacIntyre CR 2015: Current practices and barriers to the use of facemasks and respirators among hospital-based health care workers in Vietnam. *Am J Infect Control*. 2015;43:72-7.
30. Arumuru V, Samantaray SS, Pasa J. Double masking protection vs. comfort—A quantitative assessment. *Physics of Fluids*. 2021;33(7):077120.
31. prevention CfDca. When You've Been Fully Vaccinated how to protect yourself and others Centers for disease control and prevention website: Centers for disease control and prevention; 2021 [updated 01.09.2021. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated.html>].
32. Al Naam YA, Elsafi SH, Alkharraz ZS, Alfahad OA, Al-Jubran KM, Al Zahrani EM (2021) Community practice of using face masks for the prevention of COVID-19 in Saudi Arabia. *PLoS ONE* 16(2): e0247313. <https://doi.org/10.1371/journal.pone.0247313>
33. Lee LY-k, Lam EP-w, Chan C-k, Chan S-y, Chiu M-k, Chong W-h, et al. Practice and technique of using face mask amongst adults in the community: a cross-sectional descriptive study. *BMC Public Health*. 2020;20(1):948.
34. Prevention CfDca. Scientific Brief: SARS-CoV-2 Transmission Centers for Disease Control and Prevention website: Centers for Disease Control and Prevention; 2021 [Available from: <https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html>].
35. Yi H, Pingsterhaus A, Song W. The adverse effect of wearing a face mask during the COVID-19 pandemic and benefits of wearing transparent face masks and using clear speech on speech intelligibility. 2021.
36. Mejjad N, Cherif EK, Rodero A, Krawczyk DA, El Kharraz J, Moumen A, et al. Disposal Behavior of Used Masks during the COVID-19 Pandemic in the Moroccan Community: Potential Environmental Impact. *International Journal of Environmental Research and Public Health*. 2021;18(8):4382.
37. Islam S, Safiq MB, Bodrud-Doza M, Mamun MA. Perception and Attitudes Toward PPE-Related Waste Disposal Amid COVID-19 in Bangladesh: An Exploratory Study. *Frontiers in Public Health*. 2020;8:699.
38. Allison AL, Ambrose-Dempster E, T Aparsi D, Bawn M, Casas Arredondo M, Chau C, et al. The environmental dangers of employing single-use face masks as part of a COVID-19 exit strategy. 2020.
39. El-Ramady H, Brevik EC, Elbasiouny H, Elbehiry F, Amer M, Elsakhawy T, et al. Planning for disposal of COVID-19 pandemic wastes in developing countries: a review of current challenges. *Environmental Monitoring and Assessment*. 2021;193(9):1-15.
40. Hantoko D, Li X, Pariatamby A, Yoshikawa K, Horttanainen M, Yan M. Challenges and practices on waste management and disposal during COVID-19 pandemic. *Journal of Environmental Management*. 2021;286:112140.
41. Wang M, Zhou M, Ji G, Ye L, Cheng Y, Feng Z, et al. Mask crisis during the COVID-19 outbreak. *Eur Rev Med Pharmacol Sci*. 2020;24(6):3397-9.
42. Somani M, Srivastava AN, Gummadivalli SK, Sharma A. Indirect implications of COVID-19 towards sustainable environment: an investigation in Indian context. *Bioresource Technology Reports*. 2020;11:100491.
43. Voudrias EA. Technology selection for infectious medical waste treatment using the analytic hierarchy process. *Journal of the air & waste management association*. 2016;66(7):663-72.
44. MacIntyre CR, Dung TC, Chughtai AA, Seale H, Rahman B. Contamination and washing of cloth masks and risk of infection among hospital health workers in Vietnam: a post hoc analysis of a randomised controlled trial. *BMJ open*. 2020 Sep 1;10(9):e042045.
45. Machida M, Nakamura I, Saito R, Nakaya T, Hanibuchi T, Takamiya T, Odagiri Y, Fukushima N, Kikuchi H, Amagasa S, Kojima T. 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*. 2020 Jan;17(18):6484.
46. Tadesse T, Tesfaye T, Alemu T, Haileselassie W. Healthcare Worker's Knowledge, Attitude, and Practice of Proper Face Mask Utilization, and Associated Factors in Police Health Facilities of Addis Ababa, Ethiopia. *Journal of Multidisciplinary Healthcare*. 2020;13:1203.
47. Duong MC, Nguyen HT, Duong BT. A Cross-Sectional Study of Knowledge, Attitude, and Practice Towards Face Mask Use Amid the COVID-19 Pandemic Amongst University Students in Vietnam. *Journal of community health*. 2021:1-7.

