

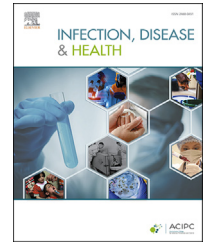


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Research paper

# Appropriate attitude promotes mask wearing in spite of a significant experience of varying discomfort

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**Abstract** *Background:* Despite increasing evidence to support mask effectiveness in mitigating the spread of COVID-19, there is still raging controversy regarding the use of masks. Evaluation of public perceptions, attitudes and the individuals' experience towards mask-wearing is integral to ensuring reasonable compliance and allows authorities to address concerns held by the population.

*Methods:* A cross-sectional survey of lay-people was conducted within a high volume tertiary level institution in Singapore, from 16 October to 16 November 2020. Surveys administered evaluated five questions: 1) duration of mask wear per day, 2) mask-type used, 3) perceived necessity, 4) discomfort level experienced and 5) causes for discomfort.

*Results:* Out of 402 respondents, 67.2% primarily wore disposable surgical masks. 72% felt mask-wearing was necessary to control COVID-19 transmission. 78.4% reported discomfort while wearing masks, with mean discomfort levels of 4.21 out of 10. Impairment to breathing and communication difficulties were the most common discomforts faced. Younger respondents complained of higher incidence of dermatological issues and sweating ( $p < 0.05$ ). Respondents who wore masks for longer duration reported higher incidence of dermatological issues ( $p = 0.001$ ) and sweating ( $p = 0.032$ ).

*Conclusion and Relevance:* Even with an available vaccine, adjunctive public health measures such as mask-wearing will likely continue in order to curb COVID-19 transmission. Experience from past pandemics is likely to propagate self-protective behavior within a community. Our study identified several common mask-wearing discomforts, allowing respective organizations valuable market feedback for research and development. With appropriate public attitudes, effective mask-wearing compliance can be attained in a concerted effort against the coronavirus.

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### Highlights

- Out of 402 survey respondents, 78.4% complained of mask-related discomfort.
  - Difficulty breathing, difficulty communicating and sweating were the top 3 causes of discomfort.
  - There was no demographic correlation to the level of discomfort reported.
  - Younger mask-wearers were more likely to report dermatological issues and sweating.
  - There was a higher incidence of dermatological issues and sweating in those who wore masks for longer hours per day.
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## Introduction

Mask-wearing is traditionally practiced for various reasons including providing protection against respiratory pathogens in pandemics such as the Spanish Flu and more recently, SARS and H1N1 [1]. Amidst the COVID-19 pandemic, community masking has been put into practice in many countries and has been shown to substantially reduce the transmission of COVID-19 amongst healthcare workers and patients [2].

SARS-CoV-2, or COVID-19, is a highly virulent organism with a high infection fatality ratio (IFR) for the elderly and those with comorbidities [3]. Public infection prevention and control (IPC) measures like community masking, hand hygiene and social distancing, as detailed by WHO guidelines [4], remain our main armamentarium in curbing the spread of COVID-19 [5]. Hong Kong, one of the first countries to adopt significant community masking practices, has seen a significantly lower rate of COVID-19 infections as compared to other Western nations [6].

The evidence to support mask effectiveness in curbing the spread of COVID-19 has been borne by both scientific experiments [7], systematic reviews [8] and epidemiological studies, documenting lower community spread and sharp decline in cases in countries adopting early mask-wear practices [9]. Early modelling of the use of moderately effective (50%) face masks by 80% of the population showed the theoretical possibility of reducing 17–45% of projected deaths and decreasing the daily peak death rate by 34–58% [10]. This assumes a reasonable degree of compliance by 80% of the general population. However, potential barriers include societal attitudes to mask wearing, lack of availability especially in the early pandemic, counter-propaganda [11], and discomforts or medical issues encountered by individuals wearing masks. Indeed, various governments have advocated widespread mask-wearing of varying degrees and at various points in the course of the pandemic. For example, the American Centre for Disease Control and Prevention (CDC) recently began advocating two-way masking [12], the concept that masking not only prevents virus spread from an infected individual, but also protects an uninfected person from contracting the virus; An idea that had been adopted by some other countries earlier in the pandemic [13].

Singapore's population was not a habitual mask-wearing society during the pre-COVID period but was hard hit economically and socially by Sars in 2003 in similarity to HK and Taiwan, thus there was greater adoption of precautions and public health measures at the onset of the pandemic. Yet the controversy regarding large scale community masking and the need to ensure reasonable compliance for masking to be effective as a measure makes it important to understand the lay individual's viewpoint and potential issues encountered while wearing masks on a daily basis.

Working on the null hypothesis that usage of face masks causes no discomfort to the individual, this study aims to explore the attitudes, mask wearing trends and potential discomfort among the lay population in a developed country. Understanding such barriers could potentially help to inform public health authorities on how best to encourage and implement mask usage within an urgent context of stemming out the upscale explosion of COVID-19.

## Methods

### Design & setting

This is a cross-sectional survey of lay individuals, conducted within a busy orthopaedic surgery outpatient setting of a tertiary level institution, which receives the highest patient volume amongst orthopaedic surgery departments in Singapore. This is essential for an amply sized study population to be accrued within a relatively short time frame, as attitudes and trends in mask wearing can swiftly evolve from time period to time period during this tumultuous pandemic. This study was conducted in the context of ongoing IPC measures in the institution and community, with active screening on all hospital visitors and strict hand hygiene practices and social distancing reinforced in the outpatient clinic.

### Participants & recruitment

The study population included patients and their accompanying persons seen in our outpatient specialist clinics. The period of study was from 16 October 2020 to 16 Nov 2020. The period corresponds to Singapore's COVID-19

Phase II re-opening; from an institutional viewpoint, patient numbers were normalizing to a pre-COVID workload while still maintaining strict temperature and contact screening precautions. The patients were seen by the various services across orthopaedic surgery within our department, ensuring that it involved a sample group representative of the population, across various socioeconomic, ethnoreligious and educational stratas. The study was administered via simple random sampling on an anonymous basis, with participation being voluntary. Printed questionnaires were distributed at random by clinic staff to patients and accompanying relatives in waiting areas, researchers were on site to clarify if queries were made.

## Outcomes & data collection

Basic demographics such as age, gender, ethnicity and occupation were recorded, but no participant identifiers were captured. The survey comprised of four questions; the brevity to minimize survey fatigue and simplicity in printed form to accommodate for varying social backgrounds. These included the duration of mask wear per day, the type used, the perceived necessity and the discomfort experienced. Pictorial examples representative of the common mask categories were provided for the participants.

Attitudes toward necessity explored the degree of personal conviction towards the need for mask wearing for the purposes of safeguarding public health during the COVID-19 pandemic, weighed against that of personal liberty. Perceived discomfort level was quantified utilising a visual analog scale in similarity to that commonly used in pain scoring, with 0 being the absence of discomfort and 10 representing extreme discomfort.

Respondents were encouraged to indicate all types of discomfort experienced and express any additional inconveniences not otherwise listed.

## Comparisons & data analysis

Statistical analysis was performed with SPSS v23 (Chicago, IL) with the univariate chi-square test being applied to discrete variables and the Student's *t*-test used to analyse continuous variables. Associations between demographic data and mask-wearing practices, attitudes and reported discomforts were explored. Correlations were made between the level and category of discomfort, versus duration of mask usage and types of masks donned. A *p*-value of 0.05 was set to define any significant correlation.

## Results

Our cross-sectional survey found *n* = 402 respondents almost quota-representative of Singaporean population demographics in terms of race distribution and age [Table 1]. The mean duration of mask-wearing was 5.98 h per day, with the majority using disposable surgical masks. Majority felt that mask-wearing was absolutely necessary to curb transmission of COVID-19 [Table 2.]

78.4% of respondents reported discomfort while wearing masks, with a mean discomfort level of 4.21 (median 4, *s.d.* 2.66, on a scale of 0–10). A detailed breakdown of the

**Table 1** Demographic data.

n = 402	
Age (years)	No. of Respondents (% of Total)
<25	25 (6.2%)
25–65	281 (69.9%)
>65	96 (23.9%)
Mean Age	52.7 (median 54, <i>s.d.</i> 16.0)
	Range 15-98
Gender	
Male	165 (43.4%)
Female	215 (56.6%)
Racer	
Chinese	255 (73.9%)
Indian	32 (9.3%)
Malay	42 (12.2%)
Others	16 (4.6%)

types of discomforts reported and their incidence is detailed in Table 3 [Table 3.].

In our analysis, we compared discomfort levels and nature of discomforts with demographic data and mask-types. We found that there was no significant difference in the mean discomfort levels reported when comparing across age groups (*p* = 0.533), gender (*p* = 0.95), race (*p* = 0.11), duration of wear (*p* = 0.169) and mask-type (*p* = 0.585). When comparing different types of discomforts reported with demographic data and mask-types, we found that more females reported discomfort of sweating

**Table 2** Mask-Wearing practices and attitudes.

n = 402	
Duration of Wear (hours)	No. of Respondents (% of Total)
0–8	288 (71.6%)
9–16	103 (25.6%)
17–24	2 (0.5%)
Mean Duration (hours)	5.98 (median 5, <i>s.d.</i> 3.89)
Type of Mask Primarily Worn	
Disposable Surgical Mask	270 (67.2%)
N95 Respirator	4 (1%)
Filter-fitted Mask	20 (5%)
Re-useable Cloth Mask	106 (26.4%)
Cloth Muffler	0 (0%)
Reason for Mask-Wearing	
Feels it is absolutely necessary for prevention of COVID-19 transmission	288 (71.6%)
Feels it offers some protection from COVID-19 transmission	63 (15.7%)
Mandated by government	30 (7.5%)
Questions the efficacy of public mask-wearing	2 (0.5%)
Absolutely will not wear a mask in public	0 (0%)

**Table 3** Breakdown of discomfort types with reported incidence.

Discomfort Types (n = 402)								
	Difficulty Breathing	Difficulty Communicating	Difficulty Recognizing Faces	Dermatological Issues (e.g. rash, acne)	Issues with Self-Appearance	Sweating	Poor fitting Spectacles	Fogging of Spectacles
Yes	215 (53.5%)	187 (46.5%)	74 (18.4%)	80 (19.9%)	10 (2.5%)	134 (33.3%)	44 (10.9%)	116 (28.9%)
No	180 (44.8%)	208 (51.7%)	321 (79.9%)	315 (78.4%)	385 (95.8%)	261 (64.9%)	351 (87.3%)	279 (69.4%)

**Table 4** Positive correlations found between specific discomfort types when compared against demographic groups, duration of wear and mask-type.

	Had Dermatological Issues		Had Sweating		Had Fogging of Spectacles	
	No. of Respondents (% of Total)	Significance	No. of Respondents (% of Total)	Significance	No. of Respondents (% of Total)	Significance
Gender						
Male	30 (18.6%)		<b>45 (28%)</b>		53 (32.9%)	
Female	47 (22%)		<b>82 (38.3%)</b>		58 (27.1%)	
		(p = 0.43)		(p = 0.036)		(p = 0.222)
Age (Years)						
<25	<b>12 (48%)</b>		<b>13 (52%)</b>		<b>12 (48%)</b>	
26–65	<b>60 (21.7%)</b>		<b>101 (36.6%)</b>		<b>86 (31.2%)</b>	
>65	<b>8 (8.5%)</b>		<b>20 (21.3%)</b>		<b>18 (19.1%)</b>	
		(p < 0.001)		(p = 0.004)		(p = 0.009)
Duration of Wear (hours)						
0–8	<b>43 (15.2%)</b>		<b>87 (30.9%)</b>		75 (26.6%)	
9–16	<b>32 (31.4%)</b>		<b>41 (40.2%)</b>		38 (37.3%)	
17–24	n < 5		n < 5		n < 5	
		(p = 0.001)		(p = 0.032)		(p = 0.106)
Mask Type						
Surgical Mask	<b>62 (23.5%)</b>		<b>101 (38.3%)</b>		77 (29.2%)	
N95 Mask	n < 5		n < 5		n < 5	
Filter-fitted Mask	n < 5		n < 5		7 (35%)	
Re-useable Cloth Mask	<b>15 (14.3%)</b>		<b>30 (28.6%)</b>		30 (28.6%)	
		(p = 0.029)		(p = 0.011)		(p = 0.763)

Statistically significant results in bold.

compared to males (38% vs 28%,  $p = 0.036$ ). Younger respondents complained of dermatological issues ( $p < 0.001$ ) and sweating ( $p < 0.05$ ). Respondents who wore masks for longer hours reported higher incidence of dermatological issues ( $p = 0.001$ ) and sweating ( $p = 0.032$ ) [Table 4.]

Statistical comparison between discomfort types and mask types was confounded by low usage of certain mask types, in particular N95 and filter fitted masks. Hence Pearson Chi-Square Test was conducted excluding cells with values less than 5. This showed that respondents who regularly wore surgical masks were more likely to complain of dermatological issues ( $p = 0.029$ ) and sweating ( $p = 0.011$ ) compared to those wearing re-useable cloth masks. Respondents wearing re-useable cloth masks were more likely to report poor fitting masks compared to those who wore surgical masks (12.4% vs 11%,  $p = 0.033$ ).

Analysis of mask-wearing attitudes showed no significant differences in attitudes among respondents of various age groups or race. However more females than males believed

that mask-wearing was absolutely necessary to control COVID-19 transmission (82.7% vs 65%,  $p = 0.003$ ).

## Discussion

Our study set out to explore public opinion, mask-wearing trends and its associated discomforts, and found that under mandatory mask-wearing conditions [14] majority of respondents acknowledged that mask-wearing was essential to curb COVID-19 spread. As global race for a COVID-19 vaccine continues, non-pharmacological interventions remain critical to the world's fight against COVID-19 [5,8]. It is postulated that even with the introduction of the vaccine, adjunctive public health measures will still be required in the midterm [15]. Our study found that nearly 70% of respondents thought mask wear was absolutely necessary to control spread of the virus. Respondents most commonly wore disposable surgical masks and for an average of 6 h. The most common associated discomforts

identified were difficulty breathing, communication and fogging of spectacles. Significant correlations were found between dermatological issues, sweat and fogging of spectacles, with certain demographic groups. These correlations further our understanding of this new mandatory practice which is likely to persist for the time-being.

Our study found that the commonest mask type used is the disposable surgical mask, which have been shown to be an appropriate choice of deterrence against COVID-19 [16]. Efficacies in filtration efficiency between different types of masks have been looked into, with surgical masks being superior to cloth masks [17]. Comparing N95 and surgical masks, there was no significant difference in respiratory illness events and the safety profile of surgical masks in the setting of COVID-19 [18]. Singapore increased public access of masks through organised distribution of cloth masks, explaining the sizeable proportion of our respondents (26.4%) using cloth masks regularly.

Approximately 72% of our population believe that mask-wearing is absolutely necessary to control COVID-19 transmission. No significant differences in attitudes was observed between age or race groups. This suggests that with public education and appropriate attitudes, effective levels of compliance can be achieved. Perceptions and behaviours of individuals evolve rapidly during pandemics and attitudes towards mask-wearing have been evaluated in countries like Hong Kong after the SARS epidemic [19]. Lau et al. anticipated a psychological public response to any new pathogen and it was concluded that in the event of future novel respiratory illness outbreak, the Hong Kong public had a high likelihood of upholding preventive measures for self-protection and protection of the community [20]. The gravity of these behavioural response forms an integral part of effective implementation, and dissemination of accurate information through public health education campaigns may reduce anxiety levels and deter inappropriate behaviours [19]. Having been through past pandemics such as SARS, such experience is likely to similarly propagate self-protective behaviours within our Singapore community. A higher percentage of females perceived the necessity for mask wearing to curb disease transmission compared to males. This could be related to a higher tendency for females to engage in protective behaviours as it was previously shown that masking correlated positively with other protective behaviours [21].

Nearly 80% of our survey participants reported discomfort in mask-wearing, with a median discomfort level of 4 out of 10. Respondents who wore masks for longer hours each day logically reported higher levels of discomfort.

More than half of our respondents complained of difficulty breathing, though there was no significant correlation with the number of hours wearing a mask. Both N95 and surgical face masks have been shown to reduce cardiopulmonary exercise capacity [22]. Studies have shown changes to the nasal airway resistance and minimum cross-sectional area in the time after wearing N95 or surgical masks [23]. Panic prone individuals have a potential risk of respiratory discomfort when wearing respiratory protective devices. However, a recent study showed no significant decline in oxygen saturation in an elderly group of patients wearing a 3-layered nonmedical face mask [24].

An under-recognised issue of mask wearing is that of verbal and non-verbal communications. Up to 46% of respondents had difficulty with communicating due to having a mask on while 18.4% reported problems with recognizing faces. Face masks were previously found to increase vocal effort, symptoms and discomfort, especially in individuals donning them for professional and essential activities [25]. As communications and facial recognition are increasingly employed by security access technologies, mitigating measures should be actively researched. Interruptions to communications also pose challenges for special needs groups including those who lip-read. Innovations like transparent face masks allowing people to lip read and see facial expressions might be useful, especially for those in the teaching field.

The use of face masks by healthcare workers has been reported to cause peri-oral dermatitis [26]. Longer hours of mask-wearing has been associated with higher rates of facial itch [27]. Szepietowski et al. reported a 19.6% incidence rate of facial itch and found that individuals with facial dermatoses were more likely to complain of facial itch after mask-wearing. This coincides with our findings where 19.9% of respondents complained of dermatological issues associated with mask-wearing, with higher reported dermatological issues in those wearing masks for longer hours. Scarano et al. reported a 0.7–1.9 °C increase in facial skin temperature while wearing N95 respirators [28]. This was less evident in individuals wearing surgical masks but both mask-types elicited sensations of facial thermal discomfort in their test subjects. While 33% of our respondents complained of uncomfortable sweating while mask-wearing, we could not determine whether those wearing N95 respirators were more likely to report such discomfort due to low absolute numbers of N95 wearers. Cloth masks tended to be of poorer fit, leading to more air leakage from the sides which in turn could explain the lower incidence of sweating and dermatological complaints.

28.9% of respondents complained of spectacle fogging when breathing through a mask. Fogging of spectacles generates an uncomfortable feeling with an impulse to touch the face [29].

Despite the high incidence of various discomforts in mask wearing, 88% of our respondents recognise its importance for public health control. We emphasize that mandatory mask-wearing was put in place in addition to travel restrictions and social distancing measures such as restricted gathering sizes, restrictions on dining-in at food outlets and enhanced screening at malls and offices. Dissemination of public health messages in Singapore were done daily through various media platforms by a Multi-Ministry Task Force. Since the implementation of these measures on April 14th 2020 [15], Singapore has seen higher mask-wearing rates compared to Western countries [30], and as of 14th November 2020 there were no locally transmitted cases amongst the Singapore population.

## Strengths

Whilst several existing studies illustrate the discomforts levels experienced by mask-wearing frontline healthcare

workers [23], to our knowledge no other articles report the public perception to mask-wearing. Our study is one of the first to distinguished various types of discomforts experienced by individual mask-wearers across various age groups and ethnicity, providing mask-producing organizations valuable market research allowing mitigation of these discomforts for specific demographic groups, with the aim to make masks more comfortable for mass usage.

### Limitations

Due to the need to maintain anonymity and encourage participation, we were unable to correlate the comorbidities of respondents to specific discomforts. Our questionnaire attempted to collect data on participant's occupations, but 28% of respondents declined to reveal their occupation, which may be due to conservative cultural attitudes, and this prevented us from performing any reliable analysis in this regard. This study is limited to a sample of the Singaporean population and other cohorts in different cultural and socioeconomic settings may yield different findings.

### Conclusion

COVID-19 measures are expected to be in place for the long term. Our study illustrates public perceptions and behaviours with regard to mask-wearing and suggests that despite the significant discomforts faced by the Singapore population, with good public attitudes, acceptable mask-wearing compliance may be achieved. This article also identifies the specific challenges associated with mask-wearing, highlighting associations between certain demographic groups with particular mask-wearing practices and discomforts. We hope that our study can bring the global collective one step closer to a unified response to the COVID-19 pandemic.

### Ethics

The survey was approved on review by our institutional review board (CIRB number 2020/2850).

### Authors statement

GJWC: Methodology, Validation, Formal Analysis, Investigation, Data Curation, Writing of Original Draft, Writing Review and Editing, Manuscript Submission. CG: Methodology, Investigation, Data Curation, Writing of Original Draft, Writing Review and Editing. CHSS: Investigation, Data Curation, Writing of Original Draft, Writing Review and Editing. YHN: Conceptualization, Methodology, Validation, Writing Review and Editing. KXKT: Conceptualization, Validation, Formal Analysis, Writing of Original Draft, Writing Review and Editing. TSH: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Writing Review and Editing, Project Administration. JSBK: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Writing of Original Draft, Writing Review and Editing, Project Administration. All authors contributed to the final analysis and interpretation of the results. All

authors contributed to the drafting of this manuscript and approved it for submission.

### Conflict of interest

None.

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### Provenance and peer review

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