

The Dilemma of Masks During the COVID-19 Outbreak

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Background: Many people have experienced novel coronavirus pneumonia since the beginning of the COVID-19 pandemic in Wuhan, China. The Chinese government has encouraged people to wear face masks in public places; however, due to the large population, there may be a series of problems related to this recommendation, including shortages of masks and lack of an optimal disposal method for used masks.

Objective: The purpose of this study is to understand the current status of mask shortages and used masks in China.

Methods: A questionnaire survey was designed to assess the current status of mask shortages and used masks. The differences among groups were analyzed with chi-square tests.

Results: The constituent ratio of those who reuse masks was 61%. Obtaining masks from the drugstore was reported to be very difficult due to high demand and short supply, and approximately 1/3 of the respondents purchased expensive masks. Most people know how to properly handle used masks, and only 7% of them casually discard masks. However, 50% of respondents have seen others throw away used masks at will. A further subgroup analysis showed that respondents in Central China tended to use masks repeatedly, as did medical personnel. Females, people living in the central region, and medical personnel may find it more difficult to purchase masks in drugstores. Non-medical personnel may be more likely to buy expensive masks. Females, people living in the western region, and medical personnel may be more likely to know how to properly handle used masks and not to discard used masks at will. Medical personnel may be more likely to observe others discarding used masks at will.

Conclusion: In response to COVID-19, the public should be encouraged to use face masks and are advised not to reuse or throw away masks at will due to safety concerns.

Keywords: COVID-19, mask, epidemic outbreak

Introduction

The outbreak of coronavirus disease 2019 (COVID-19) began in Wuhan, China at the end of December 2019,¹ and the ongoing COVID-19 epidemic poses a challenge for public health. Mounting evidence has shown that the outbreak is more widespread than was initially thought, and international spread via travelers has already occurred.²⁻⁴

Coronaviruses, which have single-stranded RNA genomes, belong to the family of Coronaviridae, and may cause respiratory and neurological diseases.⁵⁻⁷ Pneumonia resulting from COVID-19 infection mainly presents as a fever with respiratory symptoms, and is primarily spread by human-to-human transmission.⁸ Based on this, the Chinese government has encouraged people to wear masks in

public places, such as supermarkets, places of entertainment and dining, conference rooms, and public streets and squares. Masks are an important protective tool, especially for travelers.⁹ However, during the spread of a respiratory infectious disease such as the COVID-19 pandemic, how to properly use and distribute masks deserves worldwide attention.¹⁰

Masks have been considered as an essential commodity to prevent further spread of the COVID-19 pandemic. Due to the extreme shortage of personal protective equipment such as masks during the COVID-19 outbreak,¹¹ the use of reusable cloth masks has become the focus of research.¹² However, billions of single-use masks are currently being produced from petrochemical materials that do not quickly degrade after a single use, and without proper disposal, can cause environmental pollution and damage.¹³

In China and around the world, a majority of people are wearing face masks on the streets because of the COVID-19 outbreak. However, this practice has raised many questions, including whether there is a shortage of masks and how people discard used ones. Discarded masks can be found in many places, including buses, train stations, and streets. These issues are of concern, and the current status of mask shortages and mask disposal is unknown. Therefore, we designed and conducted a survey to investigate and ultimately address these issues in China, and to provide a preliminary experience for the widespread use of masks worldwide during the COVID-19 pandemic.

Methods

Study Design, Population, and Sampling

This survey was conducted from February 2, 2020 at 17:55:09 to February 4, 2020 at 19:22:05. A stratified random sampling method was used to conduct an anonymous cross-sectional online survey using the largest online survey platform in China, which is called Wen Juan Xing (Changsha Ranxing Information Technology Co., Ltd., Hunan, China). Wen Juan Xing, equivalent to Qualtrics, SurveyMonkey, or CloudResearch, provides online questionnaire design and survey functions for enterprises, research institutions, and individuals. The Wen Juan Xing sample database covers over 2.6 million respondents, whose personal information was confirmed, allowing for an authentic, diverse, and representative sample. The target population in the present study was Chinese adults living in Mainland China; thus, a random sample

procedure stratified by age and location was adopted to match Chinese adults in the Wen Juan Xing sample database. A total of 2083 individuals responded to the questionnaire, which included two parts: basic information and questions. There were 41 invalid questionnaires (lack of information and incorrect data) that were eliminated, and 2042 valid questionnaires were finally included.

Questionnaire Content Design

Basic personal information included the respondents' age, sex, region, profession, and education level. The question section of the survey consisted of two components. The first component was designed to gather information regarding the public's behavior in the face of a mask shortage. It included the following three questions: (1) Do you reuse masks? (2) Have you purchased expensive masks? (3) Can you buy a mask at the local drugstore?

The second component was designed to gather information about whether the public knows how to correctly dispose of masks, as well as observations regarding the behavior of the public in dealing with discarded masks. It included the following four questions: (1) Do you know how to correctly dispose of used masks? (2) Have you thrown away your mask at will? (3) Have you seen someone throw away a mask at will? (4) Have you seen someone pick up a discarded mask? The respondents were divided into those from the western, central, and eastern regions of China (the divisions were chosen based on economic level).

Statistical Analysis

Percentages were calculated for the frequencies. The differences among groups were analyzed with chi-square tests. $P < 0.05$ was considered to indicate statistically significant differences. All statistics were processed with SPSS 24.0 software (SPSS Inc., Chicago, IL, USA).

Data Sharing Statement

All the data and materials mentioned in the manuscript are available.

Ethics Approval and Consent to Participate

The protocol of this study was approved by the research and ethics committee of Affiliated Hospital of Hangzhou Normal University. Information regarding the purpose of the study, voluntary nature of participation, and risk

imposed due to involvement was presented in the information section of the survey. Informed consent forms were obtained from all participants. This study was conducted in accordance with the Declaration of Helsinki. Confidentiality of the information was maintained, and the data were recorded anonymously throughout the study.

Results

Baseline Information

The proportion of female respondents was higher than the proportion of male respondents. There were more respondents under 40 years of age than those over 40 years of age. The proportions of medical and non-medical personnel were basically the same. The number of respondents with a bachelor degree or above was greater than that with an education below a bachelor degree (Table 1).

Public Response to the Questions Baseline of Response to the Questions

Of the total number of respondents, 61% reported reusing masks, 32% reported purchasing expensive masks, and only 19% reported being able to buy masks at their local drugstore (Figure 1). Additionally, 86% of respondents reported knowing how to properly dispose of used masks, 7% reported having thrown away a used mask at will, and 50% reported having seen someone else throw away a used mask at will (Figure 2).

Table 1 Baseline Characteristics of the Respondents

	Num	Constituent Ratio (%)
Gender		
Male	777	38%
Female	1265	62%
Age group(year)		
<40	1398	68%
≥40	644	32%
Profession		
Medical staff	1041	51%
Non-medical staff	1001	49%
Region		
Eastern region	825	40%
Western region	605	30%
Central region	612	30%
Cultural level		
Bachelor degree or above	1599	78%
Below undergraduate level	443	22%

Repeated Use of Masks

The number of respondents who reported the repeated use of masks in the central region was greater than that in the eastern and western regions ($P < 0.05$). The number of medical personnel who reported the repeated use of masks was greater than that of non-medical personnel ($P < 0.05$). There was no difference in the repeated and non-repeated use of masks between male and female respondents ($P > 0.05$) (Table 2).

Buying Masks at the Local Drugstore

Females, people living in the central region, and medical personnel were found to be less likely to buy masks at the local drugstore ($P < 0.05$) (Table 3).

Buying Expensive Masks

Non-medical personnel were found to be more likely to buy expensive masks ($P < 0.05$) (Table 4).

Knowing How to Dispose of Used Masks

Females, people living in the western region, and medical personnel were found to be more likely to know how to properly dispose of used masks ($P < 0.05$) (Table 5).

Throwing Away Used Masks at Will

Females, people in the western region, and medical personnel were found to be less likely to throw away used masks at will ($P < 0.05$) (Table 6).

Observing Someone Throwing Away a Used Mask at Will

Medical personnel were found to be more likely to have observed someone throw away a used mask at will ($P < 0.05$) (Table 7).

Discussion

It is necessary to wear a mask when respiratory infectious diseases are prevalent, because masks play an important role in the protection of the individual.¹⁴⁻¹⁷ A study showed that surgical masks reduce virus detection in large respiratory droplets and in aerosols, suggesting that the use of surgical face masks by infected patients will reduce virus transmission.¹⁷ However, not all people are willing to wear masks. Although the prevalence rate of face mask use was fairly low in places such as Ahvaz, Iran,¹⁸ the government has made it mandatory to wear masks in public in China. As the COVID-19 outbreak progressed, people rushed to buy masks, and they quickly became scarce.¹⁹ Thus, this survey was conducted to investigate mask shortages and mask disposal in China.

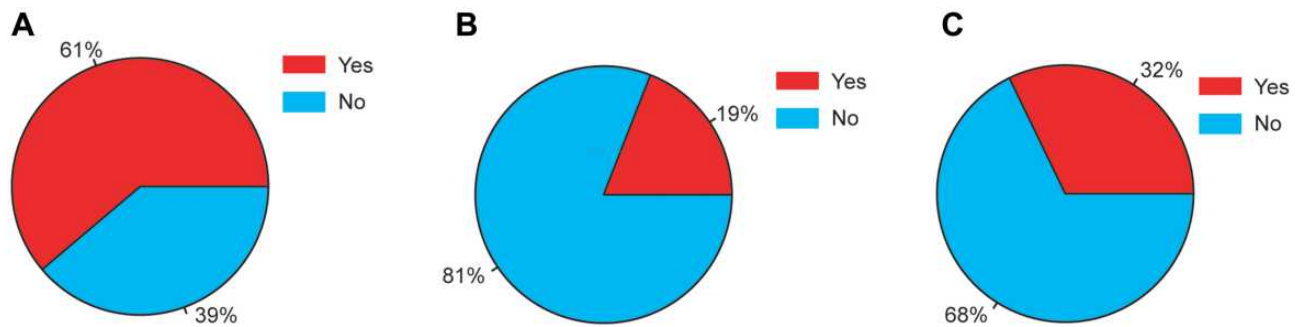


Figure 1 Pie chart showing answers. (A) Constituent ratio of reusing masks is 61%; (B) Constituent ratio of obtaining masks at the local pharmacy is 19%; (C) Constituent ratio of buying expensive masks is 32%.

Notes: (A) Whether to reuse the mask? (B) Can you get masks at the local pharmacy? (C) Do you buy expensive masks? The respondent should supply one answer, yes or no.

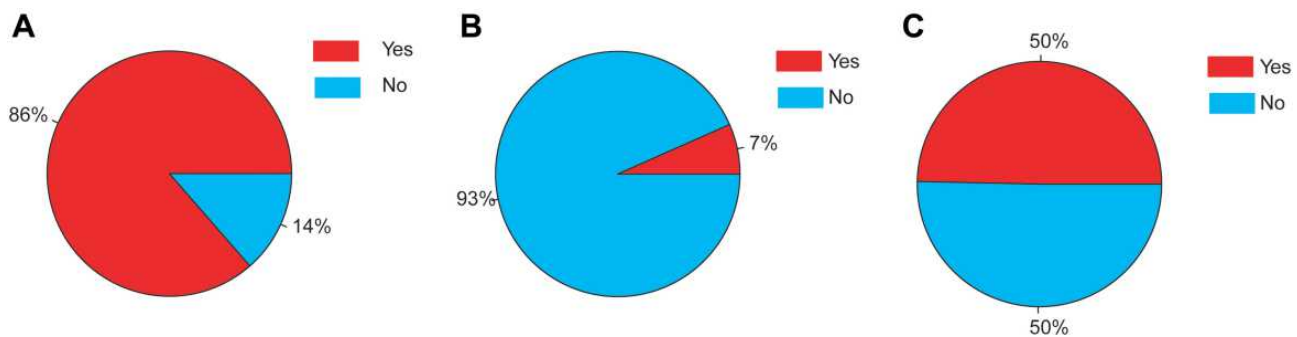


Figure 2 Pie chart of answers. (A) Constituent ratio of knowing what to do with the used mask is 86%; (B) Constituent ratio of discarding the used masks by themselves at will is 7%; (C) Constituent ratio of observing others throw away their used masks is 50%.

Notes: (A) Do you know how to deal with used masks the correct way? (B) Have you thrown away your mask at will? (C) Do you see people discarding their masks at will? The respondent should supply one answer, yes or no.

In this investigation, it was found that the constituent ratio of the respondents who reuse masks was 61%. Additionally, our investigation shows that obtaining masks from a local drugstore was reported to be very difficult, and approximately 1/3 of the respondents purchased expensive masks. It is unclear here whether respondents purchased expensive masks because the less costly masks were constantly out of stock in drugstores, and the expensive masks were the only ones available, or whether these respondents did not feel that the inexpensive masks offered sufficient protection and were willing to pay more to buy an expensive mask that provided a more solid barrier against the virus.

Additionally, most respondents know how to properly dispose of used masks, and only 7% have casually discarded masks. However, 50% of respondents have seen others discarding used masks at will. The survey results indicate that there is a current shortage of masks. China has a population of 1.4 billion. Assuming that 2/3 of the people in China must wear a mask every day, the daily

demand for masks will reach 900 million. However, this particular epidemic breakout occurred during the Spring Festival, when the mask factory was closed and the factory workers were on vacation. Although some workers have returned to work because of the government's appeal, the factory is far from reaching 100% of its production capacity, and masks therefore remain in short supply. Because of this imbalance between supply and demand, it is difficult for people to buy masks at drugstores because they are not in stock, and as a result, some people have purchased expensive masks.

Further analysis revealed some very interesting differences among the respondents. Females, people living in the central region, and medical personnel may have more difficulty in obtaining masks from drugstores, and non-medical personnel may be more likely to buy expensive masks. Additionally, respondents in the central part of China tend to use masks repeatedly, as do medical personnel. These findings indicate that healthcare workers are more likely to be mask-deficient and must therefore resort

Table 2 Differences in Gender, Region and Occupation Between Repeated Use and Non-Repeated Use of Masks. The Number of People with Repeated Use of Masks in Central Region Was More Than These in Eastern Region and Western Region ($P<0.05$); the Number of Medical Staff with Repeated Use of Masks Was More Than That of Non-Medical Staff ($P<0.05$). There Was No Difference Between Male and Female ($P>0.05$)

Variable	Yes	No	χ^2	P value
Sex			1.01	0.31
Male	464(59.7%)	313(40.3%)		
Female	785(57.5%)	580(42.5%)		
Region			49.28	$P<0.05$
Eastern region	483(58.5%)	342(41.5%)		
Western region	328(53.6%)	284(46.4%)		
Central region	438(72.4%)	167(27.6%)		
Profession			100.82	<0.05
Medical staff	719(69.1%)	322(30.9%)		
Non-medical staff	471(47.1%)	530(52.9%)		

Note: Do you reuse masks? The answer is yes or no.

to wearing the same mask multiple times. In Wuhan, China, the center of the epidemic, masks may be far scarcer.

Another important question is how to dispose of used masks. Most of the respondents reported that they know how to dispose of used masks and would not throw away used masks at will. However, 50% of the respondents reported having seen someone throwing away a used mask at will. Such an outcome indicates that there are many people who do not know what to do with their used masks. In the analysis of subgroups, medical personnel

Table 3 Differences in Gender, Region and Occupation Between Getting the Masks and Not Getting the Mask in Drugstore. Female, the People Living the Central Region and Medical Staff May Be More Likely to Be Unable to Buy a Mask ($P<0.05$)

Variable	Yes	No	χ^2	P value
Sex			16.02	<0.05
Male	183(23.6%)	594(76.4%)		
Female	206(16.3%)	1059(83.7%)		
Region			29.245	<0.05
Eastern region	153 (18.5%)	673 (81.5%)		
Western region	156 (25.4%)	456 (74.6%)		
Central region	81 (13.4%)	524(86.6%)		
Profession			331.04	<0.05
Medical staff	158 (15.2%)	883(84.8%)		
Non-medical staff	231 (23.4%)	770(76.6%)		

Note: Can you get masks at the local pharmacy? The answer is yes or no.

Table 4 Differences in Gender, Region and Occupation Between Buying the Expensive Masks and Not Buying Expensive the Mask in Drugstore. Non-Medical Staff May Be More Likely to Be Buy an Expensive Mask ($P<0.05$)

Variable	Yes	No	χ^2	P value
Sex			4.00	0.05
Male	229 (29.5%)	548 (70.5%)		
Female	428 (33.8%)	837 (66.2%)		
Region			3.5965	0.17
Eastern region	283(34.3%)	542(65.7%)		
Western region	195(31.8%)	417(68.2%)		
Central region	179(29.6%)	426(70.4%)		
Profession			5.8093	0.02
Medical staff	309(29.7%)	732(70.3%)		
Non-medical staff	348(34.8%)	653(65.2%)		

Note: Do you buy expensive masks? The answer is yes or no.

Table 5 Differences in Gender, Region and Occupation Between Knowing to Deal with the Used Masks and Not Knowing to Do That. Female, the People Living in Western Region and Medical Staff May Be More Likely to Know to Deal with the Used Masks By the Right Way ($P<0.05$)

Variable	Yes	No	χ^2	P value
Sex			42.71	<0.05
Male	622(80.0%)	155(20.0%)		
Female	1143(90.3%)	122(9.7%)		
Region			18.53	<0.05
Eastern region	700(84.9%)	125(15.1%)		
Western region	553(91.1%)	52(8.9%)		
Central region	512(84.2%)	100(15.8%)		
Profession			111.59	<0.05
Medical staff	982(99.5%)	59(0.5%)		
Non-medical staff	783(78.2%)	218(21.8%)		

Note: A: Do you know how to deal with used masks by the right way? The answer is yes or no.

were found to be more likely to have observed such behavior. In fact, it was found that many used masks were discarded in different places, such as buses, train stations, hospitals, and streets.²⁰ These discarded masks may cause secondary infections, which is a foremost concern. A recent study has shown that incorrect mask treatment may increase the infection rate.¹⁷ From the findings of the present survey, it is evident that medical personnel are more careful about the disposal of used masks, and this may be because they have health and financial incentives to do so.

Therefore, the proper disposal of discarded masks should be actively promoted, and the public should be encouraged to not throw away masks at will. The

Table 6 Differences in Gender, Region and Occupation Between Throwing the Mask at Will by Themselves and Not Throwing the Used Masks at Will. Female, the People in Western Region and Medical Staff May Be More Likely to Be Unable to Throw the Used Masks at Will ($P<0.05$)

Variable	Yes	No	χ^2	P value
Sex			6.72	0.001
Male	66 (8.5%)	711 (91.5%)		
Female	69 (5.5%)	1196 (94.5%)		
Region			15.96	0.0003
Eastern region	62 (7.5%)	763 (92.5%)		
Western region	20(3.3%)	585(96.7%)		
Central region	53(8.6%)	559(91.4%)		
Profession			14.43	0.0001
Medical staff	47(4.5%)	994 (95.5%)		
Non-medical staff	88(8.8%)	913 (91.2%)		

Note: Have you thrown away your used mask at will? The answer is yes or no.

Table 7 Differences in Gender, Region and Occupation Between Finding Throwing the Used Masks by Others and Not Finding Throwing the Used Masks by Others. Medical Staff May Be More Likely to Find the Others to Throw the Used Masks ($P<0.05$)

Variable	Yes	No	χ^2	P value
Sex			0.023	0.879
Male	388 (49.9%)	389 (50.1%)		
Female	626 (49.4%)	639 (50.6%)		
Region			1.74	0.43
Eastern region	413(50.6%)	412(49.4%)		
Western region	310(51.2%)	295(48.8%)		
Central region	291(47.5%)	321(52.5%)		
Profession			94.12	<0.05
Medical staff	627 (60.2%)	414 (39.8%)		
Non-medical staff	387 (38.7%)	614 (61.3%)		

Note: Do you see people throwing masks at will? The answer is yes or no.

government should also make the appropriate recommendations for mask disposal. Recycling bins for masks should be placed in public areas, and should be very eye-catching with a prominent logo to help the public quickly identify them.

The Chinese government has taken many measures to solve this problem. Our survey was conducted at the peak of the COVID-19 outbreak in China. The rapid control of the COVID-19 epidemic in China has been due to various efforts. Face masks are an important aspect of effective prevention and control of the COVID-19 epidemic. We hope that the results of this survey can provide valuable experience and lessons for other prevention and control

efforts in the world, so as to achieve the goal of controlling the spread of the COVID-19 epidemic.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or critically revising it for important intellectual content; agreed to submit to the current journal; gave final approval for the version to be published; and agreed to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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