ORIGINAL ARTICLE

Impact on Transmissibility and Case Fatality Rate of COVID-19 of the Mandatory Face Shield Use in Addition to Mask during the Pandemic: The Philippine Experience

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ABSTRACT

Background. While wearing face shields and other gears to protect the facial mucous membranes not covered by face masks are proven to decrease the odds of infection in the hospital setting, there is no concrete evidence of its efficacy in the general public.

Objective. To determine the effectiveness of face shield use in the general public in the local setting.

Methods. This study utilized an ecological study design, with the weeks when the policy was implemented serving as the exposure variable while the weeks when the policy was not in effect, whether prior to or after, serving as control. Primary outcomes were mean incidence of COVID-19 and case fatality rate (CFR) per week.

Results. When the mandatory face shield use was implemented, the mean incidence of COVID-19 per week was higher compared to weeks when it was not implemented [93 cases per 1000 population per week (ptpw) vs 65 cases, relative risk:1.43, z=-3.79, p=0.0001]. Moreover, during weeks when only less than 50% of the population was vaccinated with first dose (93 cases ptpw vs 52 cases, RR: 1.79, z=-4.3, p<0.0001) and complete doses (93 cases ptpw vs 66 cases ptpw, RR:1.41, z=-3.69, p=0.0002), the mean incidence of COVID-19 per week were statistically higher in weeks when face shield use was in effect. Controlling the status of vaccination and the predominant strain, face shield use increased the incidence of COVID-19 cases ptpw by 38 (F=13, R^2=39%, p=0.026) to 50 (F=3.06, R^2=12.2%, p=0.032) compared to no face shield use. No difference in CFR between weeks with face shield use and no face shield use was seen (29 deaths ptpw vs 32 deaths per ptpw, p=1.0). Nevertheless, when the weeks with no vaccination (27 deaths ptpw vs 48 deaths ptpw, RR=0.56, p=0.0018), less than 50% of the population were vaccinated with first dose (30 deaths ptpw vs 50 deaths ptpw, RR:0.6, p=0.0005), and complete doses (30 deaths vs 47 deaths ptpw, RR:0.64, p=0.0042) were only considered, face shield use significantly decreased the mean CFR per week. Controlling the incidence rate of COVID-19, vaccination status, and prevalent strain, face shield use decreases the number of deaths by 26 per 1000 COVID-19 diagnosed cases (F=7.4, R^2=28.3, p=0.010).

Conclusions. In general, although face shield use increased susceptibility to COVID-19, it decreased case fatality rate in the Philippines. However, a more robust and controlled study in the future may be needed to truly justify its recommendation for the public.

Keywords: COVID-19, epidemiology, face shield, public health, Philippines

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INTRODUCTION

The extensive vaccination campaign in the past two years lowered the incidence of Coronavirus Disease - 2019 (COVID-19) caused by Severe Acute Respiratory Syndrome - Coronavirus 2 (SARS-CoV-2) worldwide. In addition, the severity of the signs and symptoms, and the case fatality rate (CFR) progressively decline, commencing a return to pre-pandemic living in most countries including the Philippines.[1] This also led to lifting of mandatory face shield use in the country.[2]

SARS-CoV-2 can be transmitted via droplet, aerosol or contact with fomite infected with the virus.[3] While droplets are heavier, usually of more than 5 um in diameter and readily fall to the ground; aerosols are smaller than 5 um, lighter, can reach a larger area and linger in the air for at least three hours, posing a higher risk of infection than droplets. Specially for plastics and stainless steels, viability of SARS-CoV-2 virus can reach up to 72 hours although its viral load logarithmically decreases within this period.[3]

Several strategies are employed to decrease the transmission of SARS-CoV-2. To prevent transmission via droplet or aerosol, physical distancing of at least 6 feet, wearing of appropriate mask, and in case of health care workers, addition of proper face shield is/are advised.[4,5] On the other hand, to decrease infection via fomite contact, people are encouraged to wash their hands and clean the surfaces of their surroundings regularly with disinfectants.[3]

While these interventions are proven to decrease the odds of transmission, there is no concrete evidence of the efficacy of face shield use in the general public.[6,7] Among health care workers, face shield is recommended in addition to mask if being sprayed, spattered, and splashed by body fluids is anticipated. Based on experimental and epidemiological studies, this intervention decreases the probability of mucosal surfaces of the face from being infected in the hospital setting by forming a barrier against droplets and sometimes aerosols.[7,8] Lindsey et al., demonstrated that around 68% of aerosols measuring 3.4 um and below are blocked after cough at a distance of 18 inches while Bentley did not find significant reduction of facial contamination after simulated dental procedure while wearing a conical face shield. While face shields are readily available and replaced in the hospitals, these are recycled and worn for few days in public. Its efficacy and safety during the pandemic in a large population has not been established.

In the Philippines, the Interagency Task Force (IATF) Resolution No. 88 is one of the controversial policies implemented by the Philippine Government during the pandemic. According to its Section [8] general provisions, *"all persons are mandated to wear full-coverage face shields together with face masks, earloop masks, indigenous, reusable, or do-it-yourself masks, or other facial protective equipment,"* allegedly to *"effectively lessen the transmission of COVID-19."*[6] However, even the local guideline where the policy is based only recommends face shield use in areas where there is high transmission as there are no high quality papers supporting its use in the public and most of its benefits are seen among health care workers.[9] Despite this, the Philippine Government insisted on its use in the whole country and those who violated were apprehended and fined.

Although face shields are relatively cheap, if used and replaced daily, a large chunk of money, especially of poor families, will be slashed from monthly wage. Not to mention the amount of trash generated every day, which, if not collected and disposed properly, can clog the urban canals, contributing to the perennial problem of flooding.(9) Neighborhood burning of waste is still rampant, although Clean Air Act has been approved several years ago. The modest benefit of face shield use from small studies is seemed to be offset by its several negative complications. Although the mandatory face shield use has been lifted in the Philippines several months ago, large studies are yet to be done to determine its impact during the height of pandemic.[10] Philippines is a case study as it is the only country which implemented such policy, hence the main objective of this study is to determine the effectiveness of face shield use in the general public in the local setting.

Significance of the Study

This study demonstrated the advantages and disadvantages of face shield use during pandemic in the general public. In creation of local and international guidelines about management of these pandemics, this study provided the baseline data about the effectiveness of face shield use in decreasing transmissibility or mortality of a respiratory infection when implemented in a nationwide manner. Whether effective or not, a lot of resources will be saved as promoting its use when it is effective will prevent more hospitalizations and death while prohibiting its use when ineffective will only not save the environment from the long-term effects of plastics but will also prompt policy makers to use the resources in more effective interventions. This study can only be done in countries where mandatory face shield use was implemented such as the Philippines.

MATERIALS AND METHODS

Sample Size and Study Type

This study utilized an ecological study design using all the weeks from the start of the pandemic (March 20, 2020) until this paper was conceptualized (November 2022). The study population was weeks during the pandemic.

Study Site

This was done in the Philippines. The weeks when the policy was implemented served as exposure variable while the weeks when the policy was not in effect, whether prior to or after, served as the control. Outcomes during weeks when the mandatory face shield use was in effect were also compared to the outcomes taken from similar weeks in Japan. Japan serves

as control to determine how face shield use fairs against one of the ideal health care systems in the world.[11]

Inclusion Criteria

Weeks with complete data about COVID-19 during the pandemic in the Philippines and Japan were included in this study. There were no exclusion criteria in this paper.

Operational Definition of the Study Variables

Dependent Variables

- Incidence of COVID-19 per week - this was defined as the number of positive cases detected divided by the total number of people tested using RT PCR in a particular week.
- Case Fatality Rate- this was defined as the number of deaths due to COVID-19 divided by the number of patients who tested positive with COVID-19 in a particular week. This denotes the severity of COVID-19.

Independent Variable

- Face Shield Use (FSU) - these were the weeks when the mandatory face shield use was implemented in the Philippines. This was from December 14, 2020 to November 15, 2021.

Possible Confounding Variables

- Adequately Vaccinated – these were the weeks when the vaccination in the Philippines reached 50% or more either with 1 dose only, complete doses or with boosters. This is based on the Department of Health Vaccination Data.[12] These numbers were divided by the midyear population of the Philippines in 2020 to determine the percent vaccinated. Ideally, 70% completed vaccination should be used as this is the local definition of herd immunity.[13] As herd immunity was not yet reached during the conceptualization of the paper, 50% was used (November 2022). This will be used in subgroup analyses, where weeks with face shield use will be compared against no face shield use when only less than 50% of the country (ideally 70%) was vaccinated.
- Predominant Strain – these were the strains identified by the Philippine Genome Center known to predominate some of the weeks during the pandemic. The strains include D416, alpha, beta, delta, and omicron.
- Country – this was either Philippines or Japan.
- Lockdown – although lockdown was an important factor to consider as it restricted movement of people, therefore possibly decreasing occurrence of outcome variables, this variable was very difficult to control. As situation changed in the country, the definition of areas to be placed in lockdown and their level of restriction also varied, and this happened in interval of two weeks.[14] Hence, despite its importance, controlling this variable was almost impossible.

Data Collection

Secondary data regarding number of cases per week, total persons tested per week, number of deaths per week, number of persons vaccinated using 1 dose, complete dose and boosters per week, and the predominant strains per week were obtained from the Philippine Department of Health and Philippine Genome Center Websites.[15] Same data from Japan were likewise provided by the Yokohama Urban Study Solutions (YUSS) program team.[16]

Data Analysis

Continuous variables including the incidence of COVID-19 per week and case fatality rate were presented as means or medians with their corresponding standard deviation or interquartile range. Categorical variables such as face shield status, country, vaccination status, and predominant strain during the pandemic were presented as proportions. Normality of the outcome variables were tested using Shapiro-Wilks test. Normally distributed outcomes were tested using unpaired t-test, otherwise rank-sum test was used. The dependent variables were compared using Face Shield status and Country as the main independent variables, initially crudely; followed by controlling possible confounders such as vaccination status and predominant strains using stratification methods or by multiple linear regression analysis or Poisson regression analysis whichever was applicable. In the case of multiple linear regression analysis, although residual normality was not achieved (Shapiro Wilk Test, $z=7.41$, $p<0.01$), multicollinearity may be absent (VIF: 6.78). All data were coded using Microsoft excel and analyzed using STATA BE 17.0 (Texas). P-value was pegged at 0.05 to determine statistically significant result.

Ethical Approval

This paper was approved by the local ethics board with review number: UPMREB 2023-0638-EX.

RESULTS

Baseline

There were 139 weeks from March 20, 2020 to November 17, 2022. The mandatory face shield use was implemented for 49 weeks (35.3%) from December 17, 2020 to November 18, 2021. The mean incidence of COVID-19 within the period of study was 79 infection per 1000 people tested via RT PCR (sd=77) (95% CI: 66.2 to 91.8 infection per 1000 people), while the mean case fatality rate was 31 deaths per 1000 people infected with COVID-19 (sd=28) (95% CI: 26.3 to 35.7 deaths per 1000 people with COVID-19).

At least 50% of the population had 1 dose of vaccine on the 91st week of the study while at least 50% received complete doses at the 96th week, both beyond the weeks when mandatory face shield use was employed. Complete vaccination with booster shots have not yet covered 50% of the population as of this writing (November 2022).

Five strains of SARS-COV-2 were experienced in the Philippines. Prior to mandatory face shield use, D416G strain was the most prevalent (30.2% of the total weeks). Alpha (8.6%), Beta (13.7%), and Delta (14.4%) strains were the dominant strains when the mandatory face shield use was implemented. Omicron variant (34.5%) was the most prevalent until the end of the study.

Face Shield vs. No Face Shield

Using Shapiro-Wilks test, the outcome variables were not normally distributed hence a non-parametric rank-sum test was used. When the mandatory face shield use was implemented, the mean incidence of COVID-19 per week was statistically higher compared to weeks when it was not implemented (93 cases per 1000 population per week vs 65 cases ptpw, relative risk (RR):1.43, z=-3.79, p=0.0001). When weeks with no vaccination were only considered, there was no significant differences between the two groups (49 cases ptpw vs 55 cases ptpw, z=0.911, p=0.37). However, during weeks when only less than 50% of the population was vaccinated with first dose (93 cases ptpw vs 52 cases ptpw, RR: 1.79, z=-4.3, p<0.0001) and complete doses (93 cases ptpw vs 66 cases ptpw, RR:1.41, z=-3.69, p=0.0002), the mean incidence of COVID-19 per week were statistically higher in weeks when face shield use was in effect. Controlling the status of vaccination (first dose only and complete dose) and the predominant strain, face shield use increased the incidence of COVID-19 cases ptpw by 38 (F=13, R^2=39%, p=0.026) to 50 (F=3.06, R^2=12.2%, p=0.032) compared to no face shield use (Table 1).

No difference in CFR between weeks with face shield use and no face shield use was seen (29 deaths ptpw vs 32 deaths per ptpw, p=1.0). However, when the weeks with no vaccination (27 deaths ptpw vs 48 deaths ptpw, RR=0.56, p=0.0018), less than 50% of the population were vaccinated with first dose (30 deaths ptpw vs 50 deaths ptpw, RR:0.6, p=0.0005) and complete doses (30 deaths vs 47 deaths ptpw, RR:0.64, p=0.0042) were only considered, Face shield use significantly decreased the mean CFR per week (Table 1).

Controlling the incidence rate of COVID-19, vaccination status, and prevalent strain, face shield use decreases the number of deaths by 26 per 1000 COVID-19 diagnosed cases (F=7.4, R^2=28.3, p=0.010)

Japan vs. Philippines

Crudely, the Philippines had significantly higher mean incidence of COVID-19 cases per week (93 cases ptpw vs 56 cases ptpw, p=0.0001) when compared to Japan as the control. However, when the weeks prior to vaccination were only considered, Philippines had significantly lower mean incidence (50 cases ptpw vs 75 cases ptpw, p=0.0068). When weeks with less than 50% of the total population were vaccinated were only considered, Philippines had significantly higher mean incidence per week (Table 2).

Similar to the first outcome, the Philippines had higher crude case fatality rate than Japan (30 deaths ptpw vs 22 deaths ptpw, p=0.006), even when weeks without vaccination (27 deaths ptpw vs 17 deaths ptpw), less than 50% vaccinated with first dose (30 deaths ptpw vs 21 deaths ptpw) and less than 50% vaccinated with complete dose (30 deaths ptpw vs 20 deaths ptpw, p=0.0014) were considered (Table 2).

Controlling the incidence of COVID-19 and vaccination, the Philippines had significantly higher case fatality rate when compared to Japan (β=0.015, F=24.26, R^2=43.6, p<0.0001).

DISCUSSION

In general, the use of face shield increased the crude mean incidence of COVID-19 infection per week and when weeks with more than 50% of the population are vaccinated with first and complete doses were excluded in the analysis; but no observed difference when all weeks with vaccination were excluded. This is in contrast with previous

Table 1. Incidence Rate of COVID-19 and Case Fatality Rate, Face Shield vs No Face Shield Use

Vaccination Status	Face Shield Use (Mean, 95% CI)	No Face Shield Use (Mean, 95% CI)	Relative Risk (RR)	*p*-value*
Incidence Rate of COVID-19 per 1000 tested per week				
Crude	93 (91 to 95)	65 (63.7 to 66.3)	1.43	0.0001
No vaccine	49 (46.3 to 51.7)	55 (53.8 to 56.2)	0.89	0.37
Less than 50% of population vaccinated with first dose	93 (91 to 95)	52 (50.9 to 53.1)	1.79	<0.0001
Less than 50% of population vaccinated with completed dose	93 (91 to 95)	66 (63.9 to 68.1)	1.41	0.0002
Case Fatality Rate (Deaths per 1000 COVID-19 cases)				
Crude	29 (28.4 to 29.6)	32 (31.3 to 32.7)	0.9	1.0000
No vaccine yet	27 (26.2 to 27.8)	48 (46.7 to 49.3)	0.56	0.0018
Less than 50% of population vaccinated with first dose	30 (29.4 to 30.6)	50 (48.8 to 51.2)	0.6	0.0005
Less than 50% of population vaccinated with completed dose	30 (29.4 to 30.6)	47 (45.8 to 48.2)	0.64	0.0042

**rank sum test*

studies involving health care workers.[5,17–20] Accordingly, the use of face shield, goggles or visors decreased the odds of being infected by MERS-COV, influenza, and COVID-19 to 0.34 times compared to no face shield users. In addition, in experimental studies, face shields decreased facial exposure to acute cough droplets by 96% and to aerosol by 68% at a distance of 18 inches.[19] Furthermore, in two recent observational studies, health care workers had 0.04 to 0.28 times odds of being infected by COVID-19 after mandatory face shield use was implemented.[21,22] Nevertheless, health care setting is different from the general public hence the external validity of the results of these studies may not be applicable to the general population. Although there is a higher probability of being infected inside a hospital, face shields are regularly replaced, face masks are abundant and of higher quality (N95), and contact surfaces are frequently disinfected hence reducing the risk of being infected through droplets, aerosols, and fomites.[17] Despite extensive literature search, no large sample studies were obtained characterizing the effect of face shield use in preventing negative outcomes of COVID-19 in the general public.

In the Philippines, face shields are mostly made of plastics which are worn by the general public for several days or until these are lost, destroyed or grossly contaminated. The viability of SARS-CoV-2 in plastics is 3-7 days, although the viral load decreases with a median half-life of 6.8 hours.[23,24] In comparison, these viruses can only persist in paper and copper materials for less than 24 hours.[23,24] Accordingly, paper and copper inactivate the virus by dehydration, oxidation, and Maillard reaction of their lipid envelope and associated protein by their absorbent and thermoconductive property, respectively. While in plastics and other water repellant materials, the viruses are protected from dehydration and heat by taking shelter in "microdrop" residues after the droplets and aerosols have "dried" up. Using microscopes, these micrometer residues were observed to persist for more than 24 hours.[23,24] As Filipinos tend to use face shield longer, the duration of their exposure is also longer, increasing their probability of being infected, hence explaining the higher incidence in the face shield group. This trend was also seen even when potential confounders such as vaccination and predominant strains were controlled.

In contrast, there was a general trend towards lower case fatality rate in the weeks where mandatory face shield use was implemented against when it was not implemented. As mentioned, although the viability of virus is prolonged in plastic, their viral load tends to decrease over time.[23] Viral load has been repeatedly proven to be associated with severity. Among patients with and without cancers, 38.8% of COVID-19 patients with high viral load died as compared to 24.1% and 15.3% with medium and low viral loads, respectively.[25] In addition, it was also observed that higher plasma viral load is associated with more severe respiratory signs and symptoms.[4,8] Originally, face shields are designed to protect the face and associated mucous membranes against large droplets suspected to contain high viral concentration.[3,7,19,20] In this regard, it seems that face shield was effective, as this trend was also observed even when the incidence rate, vaccination status, and prevalent strains were controlled.

The Philippine data were compared to Japanese data to determine how did Philippines fair compared to a country deemed to have one of the best health care services. The Philippines had worse incidence and case fatality rates than Japan, although when weeks without vaccination were only considered, the Philippines had better incidence rate. Although these findings may be explained by the gross difference between the two countries in terms of culture (Japanese wear masks even prior to pandemic), economy (Japan had higher GDP), health care service delivery, active and passive case finding (higher number of testing centers in Japan), and rate of vaccination (Japan started vaccination earlier) among others, it may also mean that there are other factors that should be considered aside from face shield

Table 2. Incidence and Case Fatality Rate of COVID 19, Philippines vs Japan

Vaccination Status	Philippines (Mean, 95% CI)	Japan (Mean, 95% CI)	Relative Risk (RR)	*p*-value*
Incidence Rate of COVID-19 per 1000 tested per week				
Crude	93 (91 to 95)	56 (54.2 to 57.8)	1.7	0.0001
No vaccine	50 (47.3 to 52.7)	75 (72.6 to 77.3)	0.68	0.0068
Less than 50% of population vaccinated with first dose	93 (91 to 95)	59 (56.6 to 61.3)	1.6	0.0005
Less than 50% of population vaccinated with completed dose	93 (91 to 95)	66 (56.6 to 61.3)	1.5	0.0049
Case Fatality Rate (Deaths per 1000 COVID-19 cases)				
Crude	30 (29.4 to 30.6)	22 (21.4 to 22.6)	1.4	0.006
No vaccine	27 (26.2 to 27.8)	17 (16.05 to 17.9)	1.6	0.03
Less than 50% of population vaccinated with first dose	30 (29.4 to 30.6)	21 (20.1 to 21.9)	1.4	0.007
Less than 50% of population vaccinated with completed dose	30 (29.4 to 30.6)	20 (19.5 to 20.5)	1.5	0.0014

**rank sum test*

use in order to decrease the transmissibility and severity of COVID-19 in the Philippines.[26] Japan has one of the oldest populations in the world, and in theory, they should be more vulnerable to severe infections. They must have done something right during the period when mandatory face shield use was implemented that the Philippines should replicate in future pandemic.[26]

Initially a parametric unpaired t-test was utilized for comparison, however, when the normality assumption was not met, a non-parametric Mann-Whitney U test was used. Despite this, the results were almost similar, reenforcing the credibility of the findings. To account for confounders, multiple regression analyses were conducted, although doing Poisson regression analysis was also considered since it only needs to satisfy fewer assumptions. However, Poisson regression analysis requires that the outcome variable be counts instead of ratio. As the number of cases and deaths per week were dependent on the number of individuals tested and the number who tested positive for the same period, respectively, we felt that multiple linear regression analysis was more appropriate than Poisson.

However, even if we controlled the possible confounders using regression analysis, it doesn't mean that we have accounted for all the possible confounders. For example, we initially thought that lockdown should be one of the variables to be controlled since it was rigorously employed in the Philippines in the initial months of the pandemic. However, as situation changed in the country, the definition of areas to be placed in lockdown and their level of restriction also varied, and this happened in interval of two weeks.[14] Hence, despite its importance, controlling this variable was almost impossible. Other variables thought to influence the infectiousness and severity of COVID-19 include presence of comorbidities, smoking status, and male sex.[25] However, especially for the presence of comorbidities and smoking status, these were not present in the open data weekly census given by the local government hence sensitivity analyses were likewise not done in these variables. Moreover, this is one of the main limitations of ecological studies. Therefore, we are limited by the open data available supplied by our Department of Health. Further, originally, weeks with less than 70% of the population vaccinated with first or complete dose will be analyzed, as this is the country's definition of herd immunity. Nevertheless, this was not done as at most only 65% of the whole Philippine population were vaccinated during the conceptualization of this paper, hence instead of 70%, 50% was used.

Although the data presented in this study came from mixed health care and public setting, the external validity may only be applied to the general public as the situation inside a health care institution is different. If future studies will be conducted, we suggest that at least cohort study design be made, controlling all the possible confounders mentioned above, and the face shield be replaced in a daily basis to check if the incidence of COVID-19 truly changes with face shield use.

CONCLUSION

In general, although face shield use increased transmissibility of COVID-19, it decreased case fatality rate of this condition in the Philippines. However, a more robust and controlled study in the future may be needed to truly justify its recommendation for the public.

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Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

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