Effectiveness Of Fabric Mask In The Community

Based on available evidence up to 16 June 2020

INTRODUCTION

On 5 June 2020, the World Health Organization (WHO) published new guidance on the use of masks for control of COVID-19. In the guidance, WHO advise that to prevent COVID-19 transmission effectively in areas of community transmission, governments should encourage the general public to wear masks in specific situations and settings as part of a comprehensive approach to suppress SARS-CoV-2 transmission. The public is encouraged to wear masks where there is widespread transmission and physical distancing is difficult, such as on public transport, in shops or in other confined or crowded environments. In areas with community transmission, people aged 60 years or over, or those with underlying conditions, should wear a medical mask in situations where physical distancing is not possible. In settings where medical masks are in short supply, medical masks should be reserved for health workers and at-risk individuals when indicated. In this situation non-medical masks or fabric masks are suggested to be used in certain settings such as in public settings (such as grocery shops, schools, churches, mosque), cramped living conditions and when using public transportation.

At the same time, WHO emphasised masks are not a replacement for physical distancing, hand hygiene and other public health measures. Masks are only of benefit as part of a comprehensive approach in the fight against COVID-19. The cornerstone of the response in every country must be to find, isolate, test and care for every case, and to trace and quarantine every contact.

This review is conducted to assess the evidence on effectiveness of fabric masks for development of a standard operating procedure for Malaysia in response to the WHO guidance.

EVIDENCE on EFFECTIVENESS and SAFETY

WHO Interim Guidance

- In areas with widespread transmission, WHO advises medical masks for all people working in clinical areas of a health facility, not only workers dealing with patients with COVID-19.

- The use of non-medical masks, made of woven fabrics such as cloth, and/or non-woven fabrics, should only be considered **for source control (used by infected persons) in community settings and not for prevention.** Non medical masks can be used ad-hoc for specific activities (e.g., **while on public transport** when physical distancing cannot be maintained), and their use **should always be accompanied by frequent hand hygiene and physical distancing.**

- Non medical mask such as fabric masks **should consist of at least three layers of different materia**l as follows:

    1. an innermost layer of a hydrophilic material (e.g. cotton or cotton blends);

    2. an outermost layer made of hydrophobic material (e.g., polypropylene, polyester, or their blends) which may limit external contamination from penetration through to the wearer's nose and mouth.

    3. a middle hydrophobic layer of synthetic non-woven material such as polyproplylene or a cotton layer which may enhance filtration or retain droplets. Details of which materials we recommend for each layer are in the guidelines.

- Elastic material for making masks is not preferred as the mask material may be stretched over the face, resulting in increased pore size and lower filtration efficiency throughout its use.

- Mask shapes include flat-fold or duckbill. It is important to ensure that the mask is designed to fit closely over the nose, cheeks, and chin of the wearer.

- Masks should only be used by a sole person and should not be shared. A wet mask should not be worn for an extended period and should be changed if wet or visibly soiled.

- Non-medical masks should be washed frequently and handled carefully, so as not to contaminate other items.

- In the context of non-medical mask shortage, face shields may be considered as an alternative. If face shields are to be used, ensure proper design to cover the sides of the face and below the chin.

- Countries should conduct good quality research to assess the effectiveness of wearing masks for the public to prevent and control transmission.

European Centre for Disease Prevention and Control (ECDC) Technical Report

Technical report on using face masks in the community provided the ECDC opinion on the suitability of face masks and other face covers in the community by individuals who are not ill in order to reduce potential pre-symptomatic or asymptomatic transmission of COVID-19 from the mask wearer to others. It was concluded that:

- The use of **medical face masks** by **healthcare workers must be given priority** over the use in the community.
- The use of face masks in public may serve as a means of source control to reduce the spread of the infection in the community by minimising the excretion of respiratory droplets from infected individuals who have not yet developed symptoms or who remain asymptomatic. **It is not known how much the use of masks in the community can contribute to a decrease in transmission** in addition to the other countermeasures.
- The use of face masks in the community **could be considered, especially when visiting busy, closed spaces,** such as grocery stores, shopping centres, or when using public transport.
- The use of **non-medical face masks made of various textiles could be considered,** especially if – due to supply problems – medical face masks must be prioritised for use as personal protective equipment by healthcare workers. This is **based on limited indirect evidence supporting the use of non-medical face masks** as a means of source control.
- The use of face masks in the community **should be considered only as a complementary measure and not as a replacement** for established preventive measures, for example physical distancing, respiratory etiquette, meticulous hand hygiene and avoiding touching the face, nose, eyes and mouth.
- Appropriate use of face masks is key for the effectiveness of the measure and can be improved through education campaigns.
- Recommendations on the use of face masks in the community should carefully take into account evidence gaps, the supply situation, and potential negative side effects.

The United States Centers for Disease Control and Prevention (CDC)

The recommendation regarding the use of cloth face coverings, especially in areas of significant community-based transmission by the CDC outlined that:

- CDC recommends wearing cloth face coverings **in public settings where other social distancing measures are difficult to maintain** (e.g., grocery stores and pharmacies) especially in areas of significant community-based transmission.
- Maintaining 6-feet social distancing remains important to slowing the spread of the virus. The use of simple cloth face covering is an **additional advice** to slow the spread of the virus and help people who may have the virus and do not know it from transmitting it to others. Hence, cloth face coverings fashioned from household items or made at home from common materials at low cost can be used as an **additional, voluntary public health measure**.

Other evidence

1. A rapid systematic review published on 30 April 2020 included eight randomised controlled trials (published between 2008-2012) on the use of masks in the community to prevent infection. The results showed masks appear to be more effective than hand hygiene alone, and both together are more protective (Aiello et al., 2012, Aiello et al., 2010). However, the randomised controlled trials which measured both hand hygiene and masks measured the effect of hand hygiene alone, but not of masks alone (Aiello et al., 2012, Aiello et al., 2010, 16). Masks were only examined in combination with hand hygiene. Therefore, the protective effect of masks and hand hygiene combined could be due to both interventions together, or the effect of masks alone. The use of hand hygiene alone in these trials was not effective. In more than one trial, interventions had to be used within 36 hours of exposure to be effective.
2. Ngonghala et al. in their mathematical modelling showed that the use of low efficacy masks, such as cloth masks (of estimated efficacy less than 30%), could lead to significant reduction of COVID-19 burden (albeit, they are not able to lead to elimination). Combining low efficacy masks with improved levels of the other anti-COVID-19 intervention strategies can lead to the elimination of the pandemic.
3. In another model simulation, Eikenberry et al. found that even 50% coverage with 50% effective masks roughly halves the effective disease transmission rate. Widespread

adoption, say 80% coverage, of masks that are only 20% effective still reduces the effective transmission rate by about one-third. Hypothetical mask adoption scenarios, for Washington and New York state, suggested that immediate near universal (80%) adoption of moderately (50%) effective masks could prevent on the order of 17-45% of projected deaths over two months in New York, while decreasing the peak daily death rate by 34-58%, in absent of other changes in epidemic dynamics. Even very weak masks (20% effective) can still be useful if the underlying transmission rate is relatively low or decreasing: In Washington, where baseline transmission is much less intense, 80% adoption of such masks could reduce mortality by 24-65% (and peak deaths 15-69%), compared to 2-9% mortality reduction in New York (peak death reduction 9-18%).

4. Chu et al. in their systematic review and meta-analysis included 29 unadjusted studies and ten unadjusted studies on the use of both N95 or similar respirators or face masks (eg. disposable surgical face masks, or similar reusable 12 - 16 layer cotton masks) by those exposed to infected individuals. The results showed that mask usage was associated with a large reduction in risk of infection (unadjusted n=10170, RR 0.34, 95% CI: 0.26, 0.45, adjusted studies n=2647, aOR 0.15, 95% CI: 0.07, 0.34).

5. Konda et al. evaluated filtration efficiencies as a function of aerosol particulate sizes in the 10 nm to 10 μm range, which is particularly relevant for respiratory virus transmission. The results showed that the filtration efficiencies for various fabrics when a single layer was used ranged from 5 to 80% and 5 to 95% for particle sizes of <300 nm and >300 nm, respectively, the efficiencies improved when multiple layers were used and when using a specific combination of different fabrics. Filtration efficiencies of the hybrids (such as cotton–silk, cotton–chiffon, cotton–flannel) was >80% (for particles <300 nm) and >90% (for particles >300 nm). Cotton, the most widely used material for cloth masks performs better at higher weave densities (i.e., thread count) and can make a significant difference in filtration efficiencies as shown in Table 1. Fabrics that are porous should be avoided. Combining layers to form hybrid masks, leveraging mechanical and electrostatic filtering may be an effective approach. This could include high thread count cotton combined with two layers of natural silk or chiffon, for instance. A quilt consisting of two layers of cotton sandwiching a cotton−polyester batting also worked well. In all of these cases, the filtration efficiency was >80% for <300 nm and >90% for >300 nm sized particles.

Table 1. Filtration Efficiencies of Various Test Specimens at a Flow Rate of 1.2 CFM and the Corresponding Differential Pressure (ΔP) across the Specimen			
	Filter efficiency (%)		**Pressure differential**
Fabric	**<300 nm average ± error**	**>300 nm average ± error**	**ΔP (Pa)**
N95 (no gap)	85 ± 15	99.9 ± 0.1	2.2
N95 (with gap)	34 ± 15	12 ± 3	2.2
Surgical mask (no gap)	76 ± 22	99.6 ± 0.1	2.5
Surgical mask (with gap)	50 ± 7	44 ± 3	2.5
Cotton quilt	96 ± 2	96.1 ± 0.3	2.7
Quilter's cotton (80 TPI), 1 layer	9 ± 13	14 ± 1	2.2
Quilter's cotton (80 TPI), 2 layers	38 ± 11	49 ± 3	2.5
Flannel	57 ± 8	44 ± 2	2.2
Cotton (600 TPI), 1 layer	79 ± 23	98.4 ± 0.2	2.5
Cotton (600 TPI), 2 layers	82 ± 19	99.5 ± 0.1	2.5
Chiffon, 1 layer	67 ± 16	73 ± 2	2.7
Chiffon, 2 layers	83 ± 9	90 ± 1	3.0
Natural silk, 1 layer	54 ± 8	56 ± 2	2.5
Natural silk, 2 layers	65 ± 10	65 ± 2	2.7
Natural silk, 4 layers	86 ± 5	88 ± 1	2.7
Hybrid 1: cotton/chiffon	97 ± 2	99.2 ± 0.2	3.0
Hybrid 2: cotton/silk (no gap)	94 ± 2	98.5 ± 0.2	3.0
Hybrid 3: cotton/flannel	95 ± 2	96 ± 1	3.0

6. Zhao et al. evaluated the filtration properties of common households of natural and synthetic materials using a modified procedure for N95 respirator approval. The results showed that common fabrics of cotton, polyester, nylon, and silk showed initial filtration efficiency of 5−25%, polypropylene (PP-4) spunbond had filtration efficiency of 6%, and paper-based products had filtration efficiency of 10−99%. However, a commonly used filtration quality factor, Q(kPa^{-1}) which determines the filter's performance showed that charged polypropylene(PP-4) nonwoven spunbond had the highest Q (30), uncharged

polypropylene (PP-4) nonwoven spunbond (16.9), cotton and polyester (5-8), silk and nylon (0.4-3) and paper-based products (1-5). A maximum Q results from a high filtration efficiency (low penetration) with low pressure drop, which is sensible for facial coverings. As cotton is a very common material for clothing, it would be beneficial to select cotton that is woven or knit at a high density such that there are no apparent pores and yarn-to-yarn gaps. If a lower density cotton is used, it may be best to use as multilayers.

7. Lustig et al. evaluated over 70 different common fabric combinations and masks under steady-state, forced convection air flux with pulsed aerosols that simulate forceful respiration in comparison with the performance of N95 mask. The pulsed aerosols contain fluorescent virus-like nanoparticles to track transmission through materials that assist the accuracy of detection. The performance criteria tested include bacterial filtration efficiency, particle filtration efficiency, fluid flow resistance, air flow resistance, flame propagation rate and skin reactivity as mandated by the National Institute for Occupational Safety and Health (NIOSH). Effective materials for face masks should comprise both absorbent, hydrophilic layers and barrier, hydrophobic layers. Effective designs are noted with absorbent layers comprising terry cloth towel, quilting cotton, and flannel. For barrier layers, the effective designs of masks consisted of OLY-FUN (nonwoven polypropylene), lab coat (polyester/polyaramid), cotton coated with spray-on fabric protector, and traditional synthetic aliphatic and aromatic polymer fibers. Although some terry cloth and cotton multilayers are effective alone, inclusion of an additional hydrophobic repelling layer is recommended to prevent wicking transport for higher volume threats.

8. Amendola et al. conducted a lab experiment to assess the effectiveness of seven different types of face masks made from cotton, non-woven fabric, or combination of both fabrics, compared with pharmacy-bought medical face masks. The face masks were tested in the inhalation and exhalation direction for average filtration efficiency of the particles with diameters greater than 0.28 μm. The results obtained showed that the medical face mask was characterized by average filtration efficiency of higher than 97%. For other types of masks, only the face masks fabricated with three-layers constituted by TNT (non-woven fabric material) were able to reach values higher than 95%. The average filtration efficiency for two- and three-layers cotton face masks were the lowest, ranged between 77% and 83%.

CONCLUSION

There was limited and indirect evidence on the efficacy of masks used by healthy individuals in the community. Two mathematical modelling simulations showed that wearing even low efficiency masks may halt transmission of SARS-Cov-2. Non-medical or fabric masks have been recommended by few countries to be used by the public especially in public spaces where physical distancing cannot be achieved adequately and when supply of masks is limited in which priority is given to health care workers. Hybrid fabric, high density weaved cotton and multiple layers of fabric provide better filtration efficiency. Nevertheless, masks are not a replacement for physical distancing, hand hygiene and other public health measures. Masks are only of benefit as part of a comprehensive approach in the fight against COVID-19.

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