PUBLIC HEALTH COMMUNICATION CENTRE AOTEAROA

Making the most of masks

16 September 2021

Nitasha Rimar, Lucy Telfar Barnard, Amanda Kvalsvig, Lesley Gray, Michael Baker

Masks and vaccination have a central role in minimising the health and economic impact of COVID-19, regardless of the long-term strategy we use against the pandemic. These interventions depend on both good performance and high population coverage. Here we update evidence on mask effectiveness and make the case that mask use needs to be universal in all indoor environments at Alert Level 2, including workplaces, schools, and high risk settings such as gyms.

As New Zealand's outbreak of the COVID-19 Delta variant continues, and the public becomes eager to move out of lockdown, the need to prevent new outbreaks in the community remains imperative. One of the most effective ways we can quickly accomplish a safe move down Alert Levels is through universal masking by the public.

Evidence that universal masking works

The primary mode of transmission of SARS-CoV-2 (the virus that causes COVID-19) is through respiratory droplets and aerosols that are expelled by an infected person, and inhaled by one who is uninfected. Masks block such respiratory spread of viral particles.

Universal, or mass masking, is a public health measure that works by providing both source control and protection for the wearer and people around them from inhaling viral particles. Universal masking is imperative because 59% of those who spread the virus are not symptomatic, and the chance of viral transmission is highest early on in the disease before people elicit any symptoms [1]. This strategy differs from the use of masks as personal protective equipment (PPE) by groups such as health care workers [2, 3]. In that situation the focus is on giving the wearer a very high level of protection from infection. In pandemic situations, universal masking aims to reduce the spread of infection to protect both the wearer and those around them.

The effectiveness of universal masking in reducing the spread of COVID-19 is described in a range of evidence-based articles. Here we describe several well documented examples of their effectiveness:

- Laboratory studies have demonstrated that multilayer homemade cloth masks can filter SARS-CoV-2 sized particles [4, 5].
- A range of observational studies have shown the effectiveness of masking in preventing transmission. One example traced the contacts of two hairstylists who were symptomatic for COVID-19, but remained undiagnosed at the time they interacted with 139 clients. Compliant mask use amongst both stylists, and all clientele, resulted in no secondary viral transmission [6].
- Similarly, amongst 382 military members aboard a seafaring aircraft carrier, those who reported wearing a face cover had a significantly lower likelihood of infection as compared to other infection prevention measures such as avoiding common areas or social distancing [7].
- Yet another observational study examined the impact of mask mandates in multiple U.S. states from April to May 2020, finding that improved masking averted as many as 200,000 cases of COVID-19 during that time [8], while researchers who surveyed 378,207 people across the USA found people and communities with higher mask use had lower COVID-19 transmission [9].
- An intervention study from Bangladesh compared 2 groups of villagers – one group was provided masks and education regarding proper use, and another group received none of the above. Researchers found that mask use resulted in a relative risk reduction of contracting COVID-19 by up to 34.7% [10].
- As well as laboratory, observational and intervention studies, the efficacy of masking has been subject to multiple systematic reviews. In 2020, a systematic review of 21 studies on mask efficacy for preventing respiratory virus transmission, found masks protect both health care workers and other populations against respiratory virus infections, and that effectiveness was proven in a range of settings, populations and areas [11]. In January this year, a systematic review of 35 studies supported the use of face masks in the community for COVID-19 prevention, and encouraged further randomised trials [12]. In April, a further review highlighted the effectiveness of mask wearing in preventing COVID-19 infection [13]. A June systematic review concluded “all available epidemiologic evidence suggests that community-wide mask-wearing results in reduced rates of COVID-19 infections” [14].
- Taking these and the many other sources of evidence into account, a number of organisations have issued guidelines or evidence summaries recommending community masking as an important part of the arsenal of measures to reduce COVID-19 transmission. These organisations include the WHO [15], the US CDC [16], and the European CDC [17].

Extensions of settings where mask use is needed

Mask use has recently been mandated for a range of locations at Alert Level 2 in light of the Delta variant, although this requirement is not consistent to all indoor environments in Level 2 regions. This situation is occurring even when Alert Level 2 areas share contiguous land boundaries with Auckland where the outbreak is continuing and Alert Level 4 restrictions apply. Further, there are around 3000 essential workers crossing those boundaries daily.

Inconsistencies and gaps in mask use requirements need to be addressed if we are to come out of this lockdown quickly and safely, and to reduce the need for future moves up the Alert Level scale. Guidelines for 1 and 2 metre physical distancing are based on antiquated studies from the 1930s [18]. Technological advances show that simply breathing, talking, laughing, sneezing, singing or shouting, as well as coughing, can actually propel viral respiratory particles up to 8 metres in an un-masked individual (Figure 1) [18, 19].

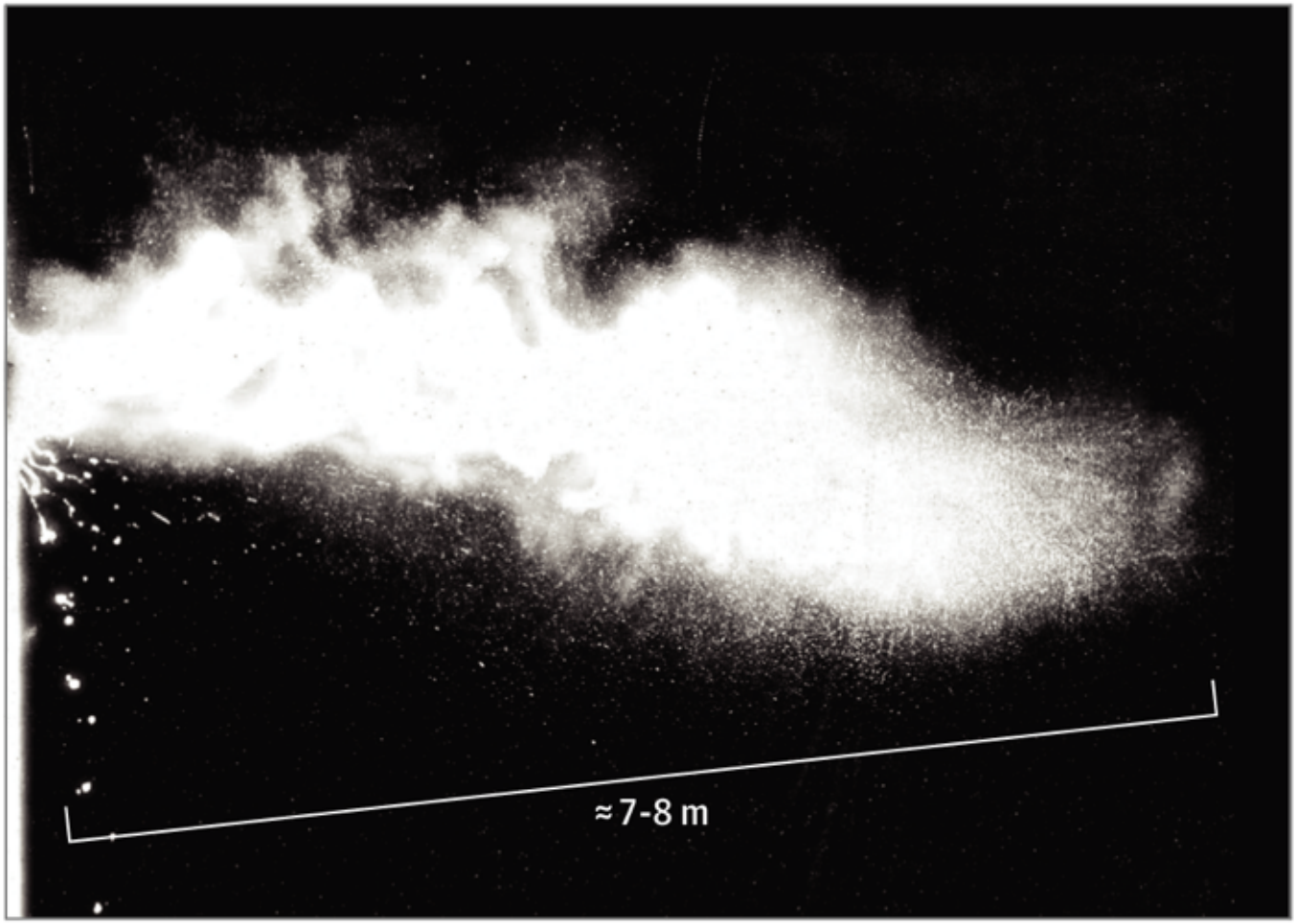

Fig. 1 – The extended reach of an infectious gas cloud from a human sneeze [18]

Here we comment on indoor environments where there is not a requirement to wear masks. We consider there are good arguments for requiring universal masking in these settings:

Bars, nightclubs, gyms, restaurants, churches, and indoor social settings – While there may be hesitation to utilize masks in settings which involve maximal respiratory effort (e.g. singing in churches, exhaling heavily during exercise in gyms, energetic children in primary schools, active indoor workplaces, and nightclubs where there is often dancing), it is precisely these venues that pose higher risks for transmission of SARS-CoV-2 from

airborne particles expelled by heavy exhalation [3, 20]. New Zealand's own experience during this current outbreak highlighted how there was a high rate of transmission of COVID-19 amongst individuals in the Mangere church cluster.

Studies have shown that surgical and cloth masks do not limit breathing or ventilatory exchange in such setting. Masks can be successfully worn, even during vigorous exercise [3, 21, 22]. Gyms are an especially vulnerable environment where individuals are exhaling heavily and propelling potentially infectious microscopic respiratory droplets in an extended trajectory all around them. If an individual enters such a room where viral particles are airborne, a mask can reduce the probability of infection by blunting the amount of viral load that is inhaled [23, 24]. Masks should be used universally in any indoor setting where there is the possibility for viral spread amongst individuals, including non-public facing workplaces and restaurant kitchens.

The risk of contracting COVID-19 in indoor eating establishments was demonstrated by an outbreak following a Chinese New Year's Eve celebration in an indoor, poorly ventilated restaurant in Guangzhou, China in January 2020. Ten members of three non-associated families, seated at three different tables, were all infected by one symptomatic individual. The non-associated families had no close contact, and some were seated at a considerable distance from the infected individual [25].

Certainly, masks have to be removed while eating and drinking, but they should be in place when entering an establishment, placing orders, speaking to staff or other patrons prior to and following the meal. Similarly, restaurants and bars can improve airflow with open windows/doors and focus on outdoor seating, to lower the chance of viral spread. Mask use has been successfully used around the world in the aforementioned venues for the past 18 months. As a result, mask use in such settings has been integrated into guidelines from the World Health Organization, Centers for Disease Control, and multiple public health agencies globally.

Schools – It has been noted that children can harbour the same amount of virus in their nose and throat as adults [26, 27]. This renders children asymptomatic spreaders who are mixing in large numbers each day. In the U.S., 15% of total COVID-19 cases are attributed to infection in children [28]. Although children generally experience less severe disease than adults, they are still susceptible to complications of COVID-19 including the rare but serious Multisystem Inflammatory Syndrome of Children (MIS-C) [29] and "long-haul" symptoms that can leave a child with long-lasting symptoms like fatigue, breathlessness, and headaches [30].

Recently, there have been multiple reports of deaths amongst school teachers who contracted COVID-19 as schools reopened in many parts of the world. Such a scenario puts into context how the psychological impact on a child of possibly infecting their teacher, or grandparent, is far more devastating than the routine use of a mask at school. Similarly, the impact of illness/death amongst co-workers, friends at a nightclub, or members of a choir, is far greater than the inconvenience posed by mask use.

Home use – We know from global data, as well as New Zealand's own outbreak of the Delta variant, that there is a high rate of transmissibility of the virus within households. As a result, there also needs to be stronger recognition of the need for universal mask use in specific home situations, for example where an individual in the household is the contact of a known case and is in home quarantine awaiting a COVID-19 test result.

Ensuring suitable mask types and quality

In addition to wearing masks in the indoor environments described above, the effectiveness of universal masking also depends on masks being effective and fit for purpose.

In terms of choosing a mask, it is important to consider the use of medical masks or multi-layer cloth masks with tightly woven fibres (thereby limiting permeability). Gaiters, bandanas, and masks with exhaust valves have been shown to be either ineffective or counter-productive in protection and transmission of the virus (Figure 2) [5, 31, 32]. These should no longer be used. Gaiters break down large respiratory droplets into smaller ones that can remain airborne longer. Masks with exhaust valves contain small plastic one-way valves that close when the wearer breathes in, but open when they exhale, creating a doorway for release of exhaled particles. These exhaust valve masks offer poor protection to those around the wearer. As a result, they have been banned in parts of the world. There are additional useful online sources of information about choosing suitable masks and making your own.

The simple measure of improving ventilation and airflow in indoor environments can also aid in preventing viral spread.

Fig. 2 – Face masks available for use. Gaiters (image 11), bandanas (image 12), and valve masks (image 2) should be avoided [31].

Requirements for masks used for PPE in healthcare settings is a highly specialised area and outside the scope of this blog. N95 respirator masks are the gold standard for protection against SARS-CoV-2, and should be universally used by those coming into contact with COVID-19 positive individuals [2, 3]. Supplying this essential PPE item is critical to protecting our high-risk staff from an occupational hazard.

For universal masking, requirements will always be a balance between multiple factors, including their effectiveness, comfort, reusability, availability, and affordability (Figure 2). A high level of community uptake is the primary goal because even mask types that are loose-fitting and less effective can substantially reduce the amount of viral aerosols in indoor air. However, there is value in optimising the effectiveness of masks typically used in community settings. New variants are generating orders of magnitude more infectious

aerosols compared with the original pandemic virus, indicating the need for masks with higher filtration efficacy and good fit to achieve the same levels of protection as before [33].

Ensuring accessibility and equity

Mask requirements or mandates must be underpinned by accessibility support for people who need to see faces to access communication. Examples include people who are D/deaf as well as a larger proportion of the population who have a mild hearing impairment that is exacerbated by background noise in public settings. Removal of masks to communicate is not a good solution for these individuals who are made vulnerable to viral transmission as a result. Workers in public-facing roles should have training and resources to support communication needs in a flexible and appropriate way without disruption of mask use. As mask technology improves, transparent masks are likely to become more practical and more widely used.

Medical exemptions for mask use are generally few, but include trauma survivors, those with maxillofacial abnormalities, young children, or those with cognitive/developmental disorders that would prevent them from being able to adjust their mask. Mask use does not compromise breathing or gas exchange, and can be safely used while exercising. Those with underlying respiratory conditions would benefit the most from mask use as they are the population most vulnerable to severe complications of COVID-19 [3]. It is essential that people who cannot wear masks are not stigmatised. One solution would be provision of a distinctive lanyard as used in the UK to signal hidden disability.

Specific policies are needed to ensure suitable, reuseable masks are widely available for low-income New Zealanders. There are multiple approaches to production and distribution, e.g. through schools, community groups, marae, and churches.

Mask Use in Vaccinated Individuals

Mask use is important for fully vaccinated individuals as well since they can still transmit the virus, and become infected. This need was demonstrated in a recent article describing 469 individuals who were infected with the Delta variant of COVID-19 during a holiday celebration in July 2021; 74% of those infected were fully vaccinated. Of even more concern is that the viral load detected in the nasal swab specimens from the vaccinated group, was equal to that in the unvaccinated group [33]. Although vaccination does prevent severe COVID-19 and death (no deaths were reported amongst the vaccinated group), it is not fully protective against breakthrough infection with SARS-CoV-2. Universal masking can therefore become an extra layer of armour against infection. If transmission does occur, masking may also reduce the amount of viral load delivered and thus the severity of infection [23].

Mask use can also protect vaccinated individuals whose immunity may be waning. We are now seeing a rise in breakthrough infections amongst healthcare and essential workers who were amongst the first to be vaccinated 8 months ago. At the University of California, San Diego, 227 healthcare workers recently tested positive for COVID-19, 57.3% were fully vaccinated. Immunity was thought to wane to 65.5% approximately 6 months from time of vaccination [34]. Similarly, Israel has also noted waning immunity prompting the need for preventative measures such as mask use [35]. It should be noted that regardless of breakthrough infection, or waning immunity, vaccines maintain robust efficacy at preventing death or severe infection requiring hospitalization from COVID-19 [36].

Summary

In response to the current Delta variant outbreak NZ has, for the first time, a mask mandate for many indoor environments outside the home. It is now time to build on that momentum and implement a national mask strategy to ensure the appropriate use of masks for both universal masking by the public, and PPE in high risk environments. This national strategy needs to include updated guidelines and measures to ensure equitable access to appropriate masks, quality standards, education about effective use, and measures to maximise environmental sustainability (notably promoting reuseable masks where possible).

Universal masking will help stamp out the current Delta variant outbreak in Auckland, especially as we transition down Alert Levels. Along with vaccination, it is one of the realities of managing COVID-19 for the foreseeable future. We need consistent, science-based, rules to guide the effective use of this intervention in situations where it matters, particularly when battling the more infectious Delta variant of COVID-19.

* Author details: Dr. Nitasha Rimar is a U.S. trained physician specialising in Endocrinology/General Medicine who currently resides in Kerikeri, New Zealand; Lesley Gray is with the Department of Primary Health Care and General Practice, University of Otago, Wellington. All other authors are with the Department of Public Health, University of Otago, Wellington.

Feature image by Luke Pilkinton-Ching, University of Otago Wellington

References

1. Johansson, M.A., et al., *SARS-CoV-2 transmission from people without COVID-19 symptoms.* JAMA Network Open, 2021. **4**(1): p. e2035057-e2035057.
2. Howard, J., et al., *An evidence review of face masks against COVID-19.* Proceedings of the National Academy of Sciences, 2021. **118**(4).
3. Organization, W.H., *Mask use in the context of COVID-19: interim guidance, 1 December 2020*. 2020, World Health Organization.
4. Taminato, M., et al., *Homemade cloth face masks as a barrier against respiratory droplets-systematic review.* Acta Paulista de Enfermagem, 2020. **33**.
5. Wang, D., et al., *Selection of homemade mask materials for preventing transmission of COVID-19: A laboratory study.* PLoS ONE, 2020. **15**(10): p. e0240285.
6. Hendrix, M.J., et al., *Absence of Apparent Transmission of SARS-CoV-2 from Two Stylists After Exposure at a Hair Salon with a Universal Face Covering Policy – Springfield, Missouri, May 2020.* MMWR Morb Mortal Wkly Rep, 2020. **69**(28): p. 930-932.
7. Payne, D.C., et al., *SARS-CoV-2 infections and serologic responses from a sample of US Navy service members—USS Theodore Roosevelt, April 2020.* Morbidity and Mortality Weekly Report, 2020. **69**(23): p. 714.
8. Lyu, W. and G.L. Wehby, *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): p. 1419-1425.
9. Rader, B., et al., *Mask-wearing and control of SARS-CoV-2 transmission in the USA: a cross-sectional study.* The Lancet Digital Health, 2021. **3**(3): p. e148-e157.
10. J Abaluck, L.K., A Styczynski et al. *The Impact of Community Masking on COVID-19: A*

Cluster-Randomized Trial in Bangladesh. 2021; Available from: https://www.poverty-action.org/publication/impact-community-masking-covid-19-cluster-randomized-trial-bangladesh.
11. Liang, M., et al., *Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis.* Travel Medicine and Infectious Disease, 2020. **36**: p. 101751.
12. Coclite, D., et al., *Face mask use in the community for reducing the spread of COVID-19: a systematic review.* Frontiers in Medicine, 2020. **7**.
13. Liao, M., et al., *A technical review of face mask wearing in preventing respiratory COVID-19 transmission.* Current Opinion in Colloid & Interface Science, 2021: p. 101417.
14. Ju, J.T., L. Boisvert, and Y.Y. Zuo, *Face masks against COVID-19: Standards, efficacy, testing and decontamination methods.* Advances in Colloid and Interface Science, 2021: p. 102435.
15. World Health Organization. *Coronavirus disease (COVID-19) advice for the public: When and how to use masks*. 2021; Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-use-masks
16. Centers for Disease Control and Prevention. *Science Brief: Community Use of Cloth Masks to Control the Spread of SARS-CoV-2*. 2021; Available from: https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/masking-science-sars-cov2.html.
17. European Centre for Disease Prevention and Control. *Using face masks in the community: first update – Effectiveness in reducing transmission of COVID-19*. 2021; Available from: https://www.ecdc.europa.eu/en/publications-data/using-face-masks-community-reducing-covid-19-transmission.
18. Bourouiba, L., *Turbulent gas clouds and respiratory pathogen emissions: potential implications for reducing transmission of COVID-19.* JAMA, 2020. **323**(18): p. 1837-1838.
19. Verma, S., M. Dhanak, and J. Frankenfield, *Visualizing the effectiveness of face masks in obstructing respiratory jets.* Physics of Fluids, 2020. **32**(6): p. 061708.
20. Hamner, L., *High SARS-CoV-2 attack rate following exposure at a choir practice—Skagit County, Washington, March 2020.* MMWR. Morbidity and Mortality Weekly Report, 2020. **69**.
21. Samannan, R., et al., *Effect of face masks on gas exchange in healthy persons and patients with chronic obstructive pulmonary disease.* Annals of the American Thoracic Society, 2021. **18**(3): p. 541-544.
22. Shaw, K., et al., *Wearing of cloth or disposable surgical face masks has no effect on vigorous exercise performance in healthy individuals.* International Journal of Environmental Research and Public Health, 2020. **17**(21): p. 8110.
23. Gandhi, M., et al., *Masks Do More Than Protect Others During COVID-19: Reducing the Inoculum of SARS-CoV-2 to Protect the Wearer.* Journal of General Internal Medicine, 2020. **35**(10): p. 3063-3066.
24. Gandhi, M. and G.W. Rutherford, *Facial masking for Covid-19—potential for "variolation" as we await a vaccine.* New England Journal of Medicine, 2020. **383**(18): p. e101.
25. Li, Y., et al., *Probable airborne transmission of SARS-CoV-2 in a poorly ventilated restaurant.* Building and Environment, 2021. **196**: p. 107788.
26. Heald-Sargent, T., et al., *Age-Related Differences in Nasopharyngeal Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Levels in Patients With Mild to*

Moderate Coronavirus Disease 2019 (COVID-19). JAMA Pediatrics, 2020. **174**(9): p. 902-903.
27. Yonker, L.M., et al., *Pediatric severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): clinical presentation, infectivity, and immune responses.* The Journal of Pediatrics, 2020. **227**: p. 45-52. e5.
28. American Academy of Pediatrics. *Children and COVID-19: State-Level Data Report.* 2021; Available from: https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report/.
29. Radia, T., et al., *Multi-system inflammatory syndrome in children & adolescents (MIS-C): A systematic review of clinical features and presentation.* Paediatric Respiratory Reviews, 2021. **38**: p. 51-57.
30. Swartz, M.K., *Post-COVID Conditions in Children.* Journal of Pediatric Health Care, 2021. **35**(5): p. 457-458.
31. Fischer, E.P., et al., *Low-cost measurement of face mask efficacy for filtering expelled droplets during speech.* Science Advances, 2020. **6**(36).
32. Pan, J., et al., *Inward and outward effectiveness of cloth masks, a surgical mask, and a face shield.* Aerosol Science and Technology, 2021. **55**(6): p. 718-733.
33. Brown, C.M., et al., *Outbreak of SARS-CoV-2 infections, including COVID-19 vaccine breakthrough infections, associated with large public gatherings—Barnstable County, Massachusetts, July 2021.* Morbidity and Mortality Weekly Report, 2021. **70**(31): p. 1059.
34. Keehner, J., et al., *Resurgence of SARS-CoV-2 infection in a highly vaccinated health system workforce.* New England Journal of Medicine, 2021.
35. Goldberg, Y., et al., *Waning immunity of the BNT162b2 vaccine: A nationwide study from Israel.* medRxiv, 2021.
36. Thomas, S.J., et al., *Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine through 6 Months.* New England Journal of Medicine, 2021.

Public Health Expert Briefing (ISSN 2816-1203)

Source URL: *https://www.phcc.org.nz/briefing/making-most-masks*