Determinants of Protective Behaviour Adoption and the Implications for Health Authorities During a Pandemic

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ABSTRACT

Introduction: Health authorities across the world have implemented non-pharmaceutical interventions (NPIs) such as social distancing measures and hand hygiene campaigns in response to COVID-19. However, the adoption of health-protective behaviour by individuals in alignment with these interventions, although effective, is variable. **Results:** Evidence suggests that increases in perceived disease severity, disease susceptibility and intervention efficacy correlate with the adoption of protective behaviours. Additionally, external cues from select, credible sources promote behavioural adoption whilst barriers to behavioural change, such as the opportunity cost faced by the employed, dissuade adoption. Lastly, demographic and socioeconomic factors play a role with men, the young, those with lower educational status and those less socially connected being less likely to adopt protective behaviours. **Conclusion:** For health authorities, an understanding of these correlates can better inform efforts to increase adherence to NPIs and stem novel viral transmission. Approaches such as risk personalisation, the communication of evidence-based effects of interventions and education regarding lesser-used behaviours (e.g., mask-wearing) are discussed. Also highlighted is the importance of consistent communication via local actors such as General Practitioners and the role of multi-level social networks. Lastly, the need for tailored efforts to enhance protective behaviour adoption in specific sub-populations is considered.

Key words: Behaviour, Health belief model, Preventative, COVID-19.

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INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (COVID-19) was declared a pandemic by the World Health Organisation (WHO) on 11th March 2020.[1] Within 11 weeks, nearly 6 million cases were reported globally. Transmission is thought to be person-to-person, predominately via airborne routes and potentially contact routes,[2] likely by asymptomatic, pre-symptomatic and symptomatic infected indivdiuals.[1,3] With vaccines under development, the United Kingdom (UK) and other countries have implemented non-pharmaceutical interventions such as hygiene campaigns, school closures and social distancing measures as methods of infection control and containment. Despite these efforts, at the end of May 2020 almost 350 thousand deaths were attributed to COVID-19 by the WHO.[3]

Many countries, including the UK, began to relax social distancing measures and re-open non-essential businesses in June 2020. This trend was accompanied by the release of new recommendations by the WHO including for the general public to wear non-medical grade face masks (i.e., face-coverings) in public settings or when social distancing cannot be achieved, practice frequent hand hygiene and continue to "avoid groups of people and crowded spaces" regardless of face coverings.[2]

Mask-wearing, practicing enhanced hygiene and social distancing are all examples of health-protective behaviours. It is important to understand to what extent these recommended health behaviours are adopted during a crisis situation such as a pandemic.[4] This commentary looks to discuss the role of cognitive factors, demographics and external cues on the adoption of non-pharmaceutical health-protective behaviour and how a better understanding of these determinants can help inform the efforts of healthcare authorities during a pandemic.[4,5]

Non-Pharmaceutical Interventions

Strategies to reduce the morbidity and mortality associated with a viral pandemic can be broadly classified as pharmaceutical interventions, including vaccination programmes and the development and use of prophylactic and antiviral medications, and non-pharmaceutical interventions (NPIs).[6,7] The latter are key for a number of reasons. Firstly, it can take months, if not years, to develop vaccines and medicines effective against novel viruses.[8] Secondly, pharmaceutical availability can be limited and, when available, achieving sufficient utilisation by the population can be unpredictable, as was the

case with vaccines during the 2009 H1N1 pandemic in many western countries, including France.[9]

The ability of NPIs to limit the consequences of a respiratory viral outbreak has been postulated *in-silico*. Bootsman and Ferguson, investigating American city-specific responses to the 1918/19 influenza pandemic found that, using a susceptible–infected–recovered (SIR) model, a reduction in contact rates of ~20% could drive ~10% reduction in the population infected and ~30% reduction in peak incidence.[10] A recent review including 25 *in-silico* studies of severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS) and COVID-19 outbreaks concluded that the "quarantine of people exposed to confirmed or suspected cases" averted approximately 40-80% of cases and 30-60% of deaths, with quarantine in combination with other NPI(s) being even more effective.[11] Ferguson *et al.*, using an individual agent-based simulation, showed that reducing the effective reproduction rate (R) of COVID-19 below one and effectively suppressing the outbreak in the UK was possible, but required a combination of NPIs including social distancing, isolation and quarantine measures.[8] More recently, Lai *et al.* determined that without NPIs, the number of COVID-19 cases in mainland China by the end of February 2020 would likely have been 67-fold higher.[12] Case isolation was found to be more effective than travel restrictions and contact reductions, but a more rapid stemming of the outbreak was facilitated by the combination of NPIs.[12]

Although rare, observational research also supports the effectiveness of NPIs. Chowell *et al.* showed that the aggressive identification and isolation of patients during an outbreak of SARS in Toronto, Canada resulted in a dramatic reduction in total cases and mortality.[13] Significant reductions in initial COVID-19 case incidence and a decrease in R from >3 to <1 in Wuhan, China was attributed to NPIs such as travel restrictions, mask-wearing and quarantine.[1,14] This is in stark contrast to Italy, which suffered one of the highest initial rates of case fatality, where contact-tracing was limited, social distancing was difficult to impose and there were numerous large social events during the initial outbreak (e.g., the Champions League football game in Bergamo).[1,15]

NPIs include the recommendation and adoption of both preventative and avoidant behaviours (Table 1). Health-protective behaviour is behaviour aligned with an NPI, which is contrasted by maladaptive behaviour (e.g., denying a threat exists).[5] Protective behaviour is adopted during a pandemic however the question remains to what extent?

Data from previous pandemics suggests the adoption rate of protective behaviour is variable and low. ~68% of the 1,003 surveyed in France during the 2009 H1N1 pandemic were under or not at all protected due to the lack of adoption of protective behaviours recommended by the health authority, including vaccination.[9] ~40% of the 997 UK respondents surveyed during the same pandemic took some sort of protective measure.[5,18] A study of Dutch and Finnish behaviours during the 2003 SARS outbreak found <10% took personal protective actions, despite recommendations by health authorities.[5,19] Finally, a study of Taiwan during the SARS outbreak reported that on average only one in 21 asymptomatic individuals who should have quarantined did so, resulting in a <5% average quarantine rate.[11,20] These are far below the compliance assumptions made in most *in-silico* models.[8,11]

A number of decision theories help frame the drivers of health-protective behaviour adoption during a pandemic. One model is the Protection Motivation Theory (PMT), which theorizes that individuals base their reaction on: (1) their appraisal of the threat, founded on the perceived susceptibility and severity of the threat, and (2) their appraisal of their coping ability, founded on the perceived response efficacy of, and self-efficacy for, the response (Figure 1).[5] These factors are weighed against the cost of response implementation. Rationally-acting individuals will be inclined to act if their appraisal of the threat is high

and adopt a specific behaviour if the associated coping ability is high and cost low.[5] This framework is mirrored by the Health Belief Model (HBM) which theorises that an individual adopts health-promoting behaviour based on perceived severity, susceptibility and self-efficacy (as in the PMT), as well as the perceived benefits associated with the behaviour (analogous to the PMT's efficacy), barriers to adopting the behaviour (analogous to the PMT's cost) and external cues to action.[21] Lastly, socioeconomic factors have been shown to correlate with pandemic-related hospitalizations during H1N1 after controlling for clinical risk factors, which is in alignment with the Social Determinants of Health Model (SDHM).[22] Demographics and socioeconomic factors therefore also potentially play a role in the adoption of protective behaviour during a pandemic (Figure 1).[4,23]

Table 1: Protective behaviours include preventative and avoidant behaviours.

- Preventative behaviours – NPIs executed on an individual basis including:
  - Personal NPIs – "everyday preventative actions"[16] including:
    - Hand hygiene (i.e., increased frequency of handwashing)[4,17]
    - Respiratory hygiene (e.g., covering one's cough)[4,17]
    - Wearing a face mask[4,17]
  - Environmental NPIs – effective cleaning of high-contact surfaces and items[16,17]
- Avoidant behaviours – community NPIs that aim to reduce person-to-person contact and therefore transmission rates such as:
  - Isolation – separation of symptomatic individuals[8,11]
  - Quarantine – separation of asymptomatic individuals who have been in contact with suspected and/or confirmed cases[8,11]
  - Social distancing – encompasses the stoppage of mass gatherings, closure of schools and universities and distancing of the general public[8]
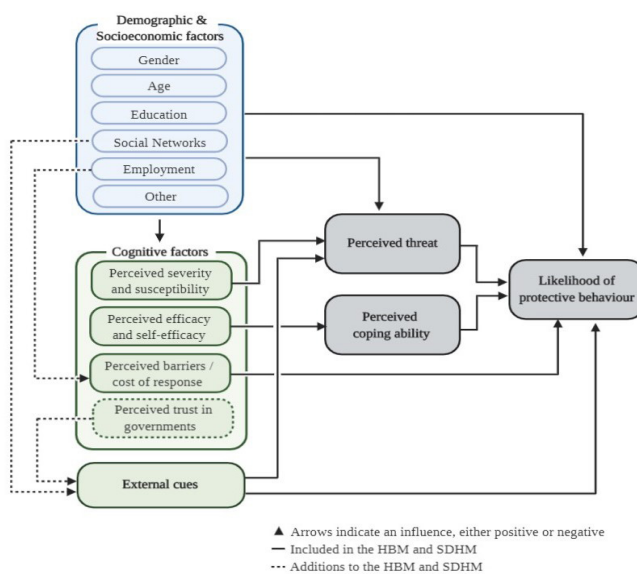

Figure 1: Demographics, socioeconomic and cognitive factors as well as external cues are theorised to influence the adoption of protective behaviour. An individual's likelihood to adopt protective behaviour as captured by the Health Belief Model (HBM), is based on cognitive factors, barriers and external cues to action (green). This is combined with demographic and socioeconomic factors as captured by the Social Determinants of Health Model (SDHM, blue). Adapted from Bish and Michie (2010)[4] and Glanz *et al.* (2015).[23]

It is important to note that the relevant literature takes both a hypothetical stated-preference approach (i.e., 'during a pandemic I would do this') and self-reported revealed preference approach (i.e., 'when there was a pandemic, I did this'). The former suffers from intention-behaviour bias, as individuals do not always act in the way they expect, and the latter from reporting bias, as individuals do not always report accurately the way they acted.[4] Despite these biases, this commentary includes literature taking both approaches, given the rarity of observational data (see Table 2 for a summary of studies included).

The potential role of cognitive as well as external cues in the adoption of protective behaviour during a pandemic, as per the HBM, as well as demographic and socioeconomic factors, as per the SDHM, will be explored in turn below.

HEALTH BELIEF MODEL

(A) Perceived severity and susceptibility

Perceived severity, likened to the perceived hardship and/or probability of dying as a result of infection, is generally found to correlate with preventative and avoidant behaviour (Table 2).[4] This is congruent with the established mantra "people respond to deaths, not infections."[10]

Perceived susceptibility, likened to an individual's believed likelihood of contracting the illness, is a correlate of preventative behaviour.[7,24] However, perceived susceptibility is inconsistently correlated with avoidant behaviour.[4] A UK,[18] and Spanish study[25] both during H1N1 correlated susceptibility with preventative and avoidant behaviours. However, two studies in the USA during H1N1 found those with higher susceptibility more likely to adopt preventative but not avoidant behaviour.[21,26] Further research spanning multiple countries is required to ascertain whether this is potentially driven by cultural differences.

Health authorities should look to leverage the potential role of perceived severity and susceptibility in protective behaviour adoption by aiming to accurately convey the risks of disease.[5,27] Risk communication techniques established in other areas of medicine could be effective including decision aids (e.g., pictographs for intervention side effects) and the use of natural frequency language instead of probabilities.[28] In particular, the personalisation of risk appears to be a strong motivator as demonstrated by "worry about oneself/ family members" being the most consistent significant correlate across variants of intended protective behaviour adoption in a Hong Kong survey.[24] Tools such as personalised risk calculators could help personalise or familiarise pandemic consequences and thereby motivate behaviour change.[28] Importantly, it is key that the risks communicated are not perceived to be exaggerated, as such a perception has been negatively correlated with the adoption of protective behaviours.[18]

Key consideration: Individuals whom perceive an outbreak to be more severe, and themselves and their family members as more susceptible to a pandemic, are more likely to adopt health protective behaviours. Health authorities therefore need to endeavour to communicate pandemic risks in an accurate and personalised manner.

(B) Perceived efficacy and self-efficacy

The perceived efficacy of an intervention is theorised to promote adoption of that behaviour. The potential power of public perception of efficacy was demonstrated by a South Korean survey post-SARS where ~80% of respondents who believed the influenza vaccination would "very likely reduce" incidence intended to vaccinate, despite vaccination having low clinical efficacy.[5,29] The impact of perceived efficacy of preventative behaviours on their adoption was shown in the UK[18] and Spain[25] during H1N1 and in Hong Kong using a hypothetical H5N1 outbreak.[24] The relationship between perceived efficacy with avoidant

behaviour is less consistent, with intervention efficacy not significantly correlated with adoption in Hong Kongese[24] and UK[18] respondents, but positively correlated in Spanish[25] and American[21] respondents during H1N1 (Table 2).

Abstracting from the efficacy of the intervention itself, an individual's ability to correctly perform the behaviour (i.e., self-efficacy) may also impact protective behaviour. Although existing studies rarely separate this from the broader perception of efficacy, a Dutch survey found self-efficacy to be a significant predictor of the adoption of protective behaviours (note that the study did not concurrently control for intervention efficacy).[30] More relevant from the perspective of a healthcare authority, self-efficacy appears to be low overall and to vary by intervention. In a Dutch stated-preference study, 29% reported being doubtful and 11% reported being unable to change their behaviour to prevent infection.[5] An American stated-preference survey found teachers "expressed the lowest confidence for [interventions] furthest from their usual behaviour" with low confidence NPIs including mask-wearing and taking student's temperatures.[17] Parents surveyed as part of the same study reflected this sentiment by having the most confidence in teacher's abilities to perform good hand-hygiene and send sick students home and less confidence in teacher's abilities to screen students for symptoms.[17] Together, these results suggest less perceived self-efficacy in behaviours further from normal behaviours.

The takeaways from these results for a health authority are twofold. Firstly, adherence to an NPI needs to be validated. Lessons from the vaccine-uptake literature apply, with recent research supporting the effectiveness of short, evidence-based, factual messages with embedded cost-benefit comparisons (e.g., adhering to quarantine for a week means you miss a pub quiz, but you also prevent 'x' people from being infected).[31] Secondly, education is required to facilitate comfort with, and therefore potential adoption of, behaviours further removed from normal behaviour, such as abiding by quarantine measures.

Key consideration: Individuals with a higher perception of intervention efficacy are more likely to adopt preventative and potentially avoidant behaviour. Additionally, perceived self-efficacy, theorised to also be a determinant of behaviour, appears to be low, especially for behaviours not otherwise used in daily life. Health strategies therefore need to focus on empowering the population to adopt protective behaviours, through education on, and validation of, specific interventions.

(C) Barriers to response

Higher barriers dissuade individuals from adopting protective behaviour. Research on the impact of direct costs of NPIs is limited with mixed results. 79% of respondents to a Dutch stated-preference survey were "(somewhat) willing" to wear a face mask in public, of which only 29% would continue to wear the mask if stigmatizing or irritating.[5] This trend is contradicted by perceived difficulty of avoiding crowds not correlating with the adoption of this behaviour in a survey of Americans during H1N1.[21] There is also limited research on the effect of the cost and availability on protective equipment (e.g., masks, hand sanitizer) on the adoption of protective behaviours.

The indirect opportunity cost of interventions appears to impact compliance, highlighting a potential interaction between the HBM and SDHM.[4] In an international stated-preference study, employed respondents were more likely to use public transportation.[27] This is partially rooted in the cost associated with missing work, as evidenced by 42% of respondents reporting the loss of pay resultant from a pandemic "would result in serious financial difficulties" after one month and 75% after a few months.[27] Similarly, 35% of respondents reported they would stay at home in accordance with government advice and in contradiction

Table 2: Summary of studies included.

Study	Design	Study population	Behaviour outcomes of interest	Drivers significantly correlated with intended/ reported behaviour*^	Drivers included but insignificantly correlated with intended/ reported behaviour*
Aguero et al. 2011[25]	H1N1 Multivariate logistic regression	Spain N = 1,627 households	Ministry of Health (MoH) recommended behaviours (respiratory hygiene, washing hands more frequently) Purchase measures (buying mask and/or hand sanitizer) Avoidance measures	Age: Younger more likely to adopt purchases measures Gender: Women more likely to adopt MoH and purchase measures Education: Increased more likely to adopt MoH and purchase measures Perceived susceptibility: All three Perceived efficacy: All three	
Barr et al. 2008[36]	Hypothetical influenza pandemic Prevalence estimates and pairwise comparisons	Australia N = 2,081	Wear a face mask Comply with isolation	Age: Older more likely to comply with isolation and wear mask Education: University-educated more likely to wear mask	Gender Employment
Brug et al. 2004[37]	SARS Pearson correlations	Netherlands N = 373	1+ Precautionary behaviours including avoiding travel to SARS-infected areas, getting sufficient sleep and wearing a mask	Perceived risk of acquiring SARS Worry about getting SARS	Perceived ability to avoid SARS Perceived ability to avoid SARS vs. others Perceived risk of acquiring SARS vs. others
Chuang et al. 2015[7]	Hypothetical influenza pandemic Multivariate regression	Taiwan N = 1,745	Wear a face mask Wash hands more frequently	Age: Older less likely to wear mask Gender: Men less likely to wear mask Education: College-educated more likely to wear mask Perceived susceptibly: Wear mask and hand washing Perceived severity: Wear mask External: Bonding and linking social capital more likely to wear mask and hand washing External: Bridging social capital more likely to wear mask	Perceived severity: handwashing External: Trust in government's capacity to handle an influenza pandemic
De Zwart et al. 2010[30]	Avian influenza Multivariate regression	Netherlands N = 3,840	Binary based on adoption of 1+ recommended behaviours (e.g., mask wearing, avoiding shaking hands)	Age Perceived severity Perceived vulnerability Perceived self-efficacy when at least sometimes thinking about flu	Gender Education
Durham et al. 2012[21]	H1N1 Multivariate regression	Pennsylvania, USA N = 293	Avoid crowds	Age: >65 years more likely Gender: Men less likely Perceived benefits Education: 4-year college degree+ less likely (note: univariate regression only, not featured in multivariate regression)	Perceived barriers Perceived severity Perceived susceptibility

Jones and Salathe, 2009[33]	H1N1 Covariate analysis	Online survey with 69% USA sample N = 6,249	Protection index (range from 0-9) based on adoption of up to 9 protective behaviours including: avoiding large gatherings of people, wearing a mask etc. Increase frequency of hand washing	Age: Protection index, hand washing Gender: Male negatively correlated with protection index, hand washing Perceived risk: Protection index, hand washing Perceived control: Negatively correlated with protection index Anxiety: Protection index, hand washing External: Receiving information from the internet and health officials correlated with protection index and hand washing External: Receiving information from the TV correlated with protection index	External: Receiving information from print-media, radio, friends and social media on protection index
Kok et al. 2010[5]	Hypothetical influenza pandemic Descriptive statistics	Netherlands N = 1,099	Behaviours including: staying indoors, staying home from work, avoiding medical professionals, avoiding social contact, wearing a face mask	N/A	N/A
Lau et al. 2007[24]	Hypothetical H5N1 outbreak Multivariate regression	Hong Kong N = 503	Wear a face mask in public (mask) Wear a face mask in public when symptomatic (mask with symptoms) Increase frequency of hand washing Comply fully with quarantine policies	Age: Mask Employed: Mask Education level: Mask with symptoms Perceived fatality rate: Mask and hand washing Worry about oneself/family contracting virus: Mask and hand washing Perceived risk of susceptibility (of children): Quarantine Perceived efficacy of intervention: Mask, mask with symptoms and hand washing	
Lau et al. 2003[41]	SARS Multivariate logistic regression	Hong Kong N = 1,397	Wear a mask Increase frequency of hand hygiene Avoid crowded places	Age: Hand hygiene, avoid crowds Gender: Females more likely wear a mask and hand hygiene Education: Avoid crowds Perceived susceptibility: Hand hygiene Perceived efficacy: Wear a mask, hand hygiene, avoid crowds	
Mitchell et al. 2011[35]	H1N1 Descriptive statistics	University in USA N = 6,049 students and 1,057 staff	Increase hand washing Increase hand sanitizing Avoid sick people Do not share drinks/utensils Do not share things sick people have touched	N/A	N/A

Rubin et al. 2009[18]	H1N1 Multivariate regression	UK N = 997	Recommended preventative behaviour change (e.g., hand washing) Avoidant behaviours (e.g., avoiding crowds)	Perceived severity: Both Perceived likelihood of contracting: Both Perceived efficacy of behaviours: Preventative behaviour Self-reported anxiety: Preventative behaviour External: Trust in authorities correlated with preventative behaviour External: Receiving good information about the outbreak correlated with preventative behaviour External: True risks of outbreak had been exaggerated negatively correlated with both	
Sadique et al. 2007[27]	Hypothetical influenza pandemic Multivariate logistic regression	5 European and 3 Asian countries N = 3,436	Avoid public transportation Avoid entertainment Limit shipping Stay home from work Keep children from school Limit contact with family/ friends Avoid seeing doctor Stay indoors	Age: Older more likely to avoid entertainment, less likely to take time off work Gender: Men less likely to limit shopping Education: Medium/ high more likely to avoid entertainment Employed: Less likely to avoid public transportation, limit shopping, take absence from work, stay indoors Perceived risk: More likely to avoid public transportation	
Setbon et al. 2011[9]	H1N1 Multivariate logistic regressions	France N = 1,003	Mixed protection strategy (vaccination and 1+ NPI) Pharmaceutical protection strategy (pharma) NPI strategy Non-protection strategy	Age: Older more likely to adopt mixed or pharma Gender: Men less likely to adopt NPI, more likely to adopt non-protection Education: Low education more likely to adopt non-protection, less likely to adopt mixed High severity: Mixed strategy High control: Mixed strategy more likely, non-protection strategy less likely	Perceived vulnerability and probability: not correlated with NPI or non-protective strategy
Stebbins et al. 2009[17]	Hypothetical seasonal influenza Pairwise comparison designed to assess acceptability of NPIs in both the school and the home settings	Grade school in Pittsburgh, USA N = 134 teachers and 151 parents	Range of behaviours, including: insisting coverage of coughs/sneezes, willingness to use hand sanitizer, willingness to wear gloves	N/A	N/A
Zottarelli et al. 2012[26]	H1N1 Multivariate regression	2 Universities in Texas, USA N = 909 students	Increase frequency of hand washing Increase frequency of hand sanitizing Avoid sick people Avoid gatherings Avoid touching eyes, nose, mouth (i.e., avoid face)	Age: Hand washing and avoid face and decreased hand sanitizing Gender: Men less likely to increase hand washing, sanitize hands and avoid face Perceived susceptibility: Increased all behaviors except avoiding gatherings Perceived health threat: Increase in all behaviors	

(*) Significance taken to be at 5% level

(^) Driver significantly positively correlated with the behaviour, unless otherwise stated

Note: Only variables discussed in broader commentary included

to that of their employer's, which dropped to 20% if staying home involved a loss in wage.[27]

Key consideration: The perception of direct barriers, such as stigmatization, and indirect barriers, such as the cost of missing work, potentially impact the adoption of protective behaviour during a pandemic however, further research is required. Health authorities therefore need to identify and develop strategies to combat both these real and potentially perceived barriers.

(D) External cues

External cues can trigger the adoption of protective behaviour. A multifaceted determinant, such cues can come from a range of sources.[32] The existence and integration of an individual in social networks, the identity and credibility of the source and the frequency and consistency of cues have been shown to be potential determinants of protective behaviour.

Three types of social network, so called social capital, originally hypothesised by Szreter and Woolcock (2004), have been shown to influence health-protective behaviour:[7]

- bonding capital – interpersonal social contacts like those with neighbours
- bridging capital – involvement in diverse civic associations
- linking capital – trust in governments and other civic institutions

Chuang *et al.*, in a Taiwanese stated-preference survey, found that the intention to wash hands more frequently was associated with linking and bonding capital, whilst the intention to wear a face mask was associated with all forms of social capital.[7] The significance of these networks, even controlling for demographic and cognitive determinants, supports the relevance of social connectedness in determining the adoption of preventative behaviour during a pandemic. The mechanism of this effect is likely to be multidimensional, with social networks promoting the diffusion of health information, the establishment of behavioural norms and the accompanying societal pressure to adhere to those norms, and the fostering of empathy and awareness during the time of a pandemic.[7]

The element of trust or perceived credibility of central authorities is considered a determinant of protective behaviour, with individuals more inclined to adapt their behaviour to align with recommendations if they trust the recommender.[4,7] A comparison of Hong Kong and Singapore during the SARS crisis highlights this. The public trust earned by the Singaporean government is credited with enhanced NPI compliance whereas the lack of trust in the government was blamed for enhanced viral transmission in Hong Kong.[4] Similarly, UK respondents during H1N1 with trust in authorities were more likely to adopt preventative behaviour.[18]

Different external influences are perceived with varying degrees of trust during a pandemic. For example, a Dutch survey determined local health authorities including General Practitioners (GPs) to be considered the most trustworthy sources of information.[5] An online survey of more than 6,000 individuals correlated receiving information from the internet, television and health officials and not information from print-media, friends or social media with increased protective behaviour.[33] Such knowledge is valuable to a healthcare authority.

The frequency and consistency of external cues have also been shown to influence protective behaviour.[4,34] For example, increases in printed media coverage of the H1N1 outbreak in the UK correlated with a significant increase in Emergency Department visits three days later.[34] Additionally, a lack of clear and consistent messaging regarding isolation and social distancing expectations was credited with a lack of adherence to such interventions during an American University's response to H1N1.[35]

Key consideration: Enhanced social connectedness and trust in central authorities promote the adoption of preventative and potentially avoidant behaviour during a pandemic. Health strategies therefore need to recognize the importance of identifying credible external sources, such as GPs and televised programs, and promote clear and consistent messaging through these channels.

SOCIAL DETERMINANTS OF HEALTH MODEL

Women and older individuals have been found to generally be more likely to adopt preventative and avoidant behaviours (Table 2). Higher educated individuals appear to be more likely to adopt preventative but not necessarily avoidant behaviour.[4] Hong Kongese respondents with university-level education were more likely to intend to wear a face mask if symptomatic, but not more likely to fully comply with quarantine policies.[24] This was reflected by an Australian stated-preference survey, with both surveys concurrently controlling for employment status.[36] This conclusion is generally supported in the literature with the exception of a Dutch survey.[30]

Important to note that these results are based on direct effects of the demographic variables (i.e., factors with significant partial effects in a multivariate regression analysis). This abstracts from the total effect a demographic variable may have on the adoption of protective behaviour taking into account its influence on cognitive and/or social determinants. As an example, women on average have higher perceived severity[21] and susceptibility,[21,37] and perceived severity has been found to be higher in the elderly.[4,21]

Interventions targeting the behaviour of the young, male and less educated, in addition to population-wide interventions, may be required to alleviate inconsistencies in behavioural adoption.[38] Learnings from other areas of public health are potentially transferrable. For example, the prostate cancer literature has found that educational pamphlets accompanied by a personalised letter sent from the individual's personal physician is an effective way to promote preventive health behaviour in males aged 40 to 60.[39] Tackling disparities in education, accompanying pictures have been shown to increase attention and retainment of health information for patients, especially those with lower rates of literacy.[40]

Key consideration: Women, the elderly and those with advanced education are more likely to adopt protective behaviour during a pandemic. Therefore, to prevent inequalities in health, strategies need to focus on promoting specifically younger males of lower educational status to practice protective behaviour. Well-designed educational communications that are personalised and leverage informative diagrams may be a mechanism by which to target these populations. Knowledge of both the direct and indirect effects of demographics could assist health authorities better target their efforts during a pandemic.

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE STUDY

Limitations of this commentary include its basis on the PMT and HBM theoretical constructs, which have be criticised for discounting the emotional determinants of behavioural change.[4] The importance of this consideration is demonstrated by feelings of anxiety correlating with protective behaviour adoption in select studies.[18,33] Given the lack of research, this discussion does not consider other potential demographic determinants such as ethnicity, household income, parenthood and marital status.[4] It also fails to distinguish between determinants of reactive behavioural change compared to compliance with mandated behavioural change.

The assessment of the various strategies employed across and within countries in response to COVID-19 to promote adherence to

recommended protective measures would greatly inform the validity of the health strategies discussed here.

CONCLUSION

NPIs are effective tools to help combat the spread of novel viruses such as COVID-19. The difficulty remains on how to ensure that protective behaviours are adopted by a sufficient proportion of the population in order to meaningfully stem viral transmission. Evidence thus far supports the theoretical constructs of the PMT and HMB with protective behaviour found to be a correlate of cognitive determinants such as perceived severity, susceptibility, efficacy and self-efficacy. Protective behaviour also appears to be positively correlated with external cues from select, credible sources and negatively with barriers to behavioural change such as the opportunity cost faced by the employed. Lastly, men, the young and the lesser educated were found to be less likely to adopt protective behaviours.

Knowledge of these correlates can help health authorities refine their efforts to better motivate behaviour change during a pandemic. Highlighted here is the importance of consistent messaging, risk personalisation, the use of factual, evidence-based effects of interventions and education around lesser-used behaviours. Additional considerations include the value of trusted local actors such as neighbours and GPs, as well as the influence of multi-level social networks. Lastly, sub-populations such as young males may benefit from tailored efforts to ensure sufficient behavioural adoption.

As the identification of significant correlates of protective behaviour adoption is continually clarified, future research should endeavour to more explicitly characterise the relative importance of each. With a more informed understanding of which determinants matter most and when, health authorities would be better equipped to optimize NPI adherence and better protect the populations they serve.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

ABBREVIATIONS

COVID-19: Severe acute respiratory syndrome coronavirus 2; **GPs:** General Practitioners; **H1N1:** Influenza A virus subtype H1N1 known as swine flu; **H5N1:** Influenza A virus subtype H5N1 known as bird flu; **HBM:** Health Belief Model; **MERS:** Middle East respiratory syndrome; **NPIs:** Non-pharmaceutical interventions; **PMT:** Protection Motivation Theory; **R:** Effective reproduction rate; **SARS:** Severe acute respiratory syndrome; **SDHM:** Social Determinants of Health Model; **SIR:** Susceptible–infected–recovered; **UK:** United Kingdom; **USA:** United States of America; **WHO:** World Health Organisation.

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