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Adherence to COVID-19 Precautionary Measures: Applying the Health Belief Model and Generalised Social Beliefs to a Probability Community Sample

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Background: In the face of the global pandemic of coronavirus disease-2019 (COVID-19), people's adherence to precautionary behavioral measures (e.g. social distancing) largely influences the effectiveness of those measures in containing the spread of the coronavirus. The present study aims at testing the applicability of the health belief model (HBM) and generalised social beliefs (i.e. social axioms) to explore strategies for promoting adherence to COVID-19 precautionary measures. **Methods:** We conducted a telephone survey with a two-step stratified random sampling method and obtained a probability sample of 616 adults in Macao, China (18–87 years old; 60.9% women) in April 2020. **Results:** Our participants showed stronger adherence to some COVID-19 precautionary measures (e.g. face mask wearing; 96.4%) but not others (e.g. social distancing; 42.3%). Their adherence to those measures was found to be significantly associated with four HBM factors and two social axioms, after controlling for gender, age, and years of education. **Conclusions:** The HBM and the generalised social beliefs of social cynicism and reward for application can be applied to understanding adherence to precautionary measures against COVID-19. Strategies based on beliefs were proposed to facilitate the promotion of precautionary measures.

Keywords: adherence, COVID-19, health belief model, precautionary measure, social axioms, social beliefs

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) was first discovered in Wuhan, China in December 2019 and it was declared a pandemic by the World Health Organization in March 2020, spreading to more than 200 territories across the globe. To control the infection, various behavioral precautions such as social distancing and personal hygiene practices have been recommended by governments. These social and behavioral containment measures are considered to be effective in suppressing the exponential growth in COVID-19 cases (Maier & Brockmann, 2020). Nevertheless, individual differences have been observed regarding behavioral adherence to precautionary measures (Abraham & Sheeran, 2005; Harper, Satchell, Fido, & Latzman, 2020). Understanding such individual differences at the intrapersonal level is essential for controlling COVID-19 transmission, especially in the absence of vaccination (Betsch, 2020). In this study, we aimed to explore how two intrapersonal-level factors (i.e. specific COVID-19 beliefs and generalised social beliefs) are associated with an individual's behavioral adherence to COVID-19 precautionary measures.

Intrapersonal factors are centered on major health behavior models with a focus on a variety of elements, such as health beliefs and disease-related fear or anxiety (Abraham & Sheeran, 2005; Harper et al., 2020). Due to the rapid spread of the virus and a dearth of verified research, current knowledge on the influence of intrapersonal factors on alleviating the COVID-19 pandemic is sparse. We made reference to the prevention strategies for the human immunodeficiency virus (HIV) epidemic and found the health belief model (HBM) promising for containing the coronavirus on the intrapersonal level, as evidenced by its successful application to enhancing HIV precautionary behaviors, including condom use (Abraham, Sheeran, Spears, & Abrams, 1992; Zhao et al., 2012), sexual partner numbers and selection (Lin, Simoni, & Zemon, 2005; Lux & Petosa, 1994), and HIV voluntary testing and counseling (Buldeo & Gilbert, 2015; Nöthling & Kagee, 2013).

The HBM is a value-expectancy theory addressing the desire to avoid disease and the belief that a health-related action can prevent it. Its components include perceived susceptibility (i.e. belief about the risk of getting a disease), perceived severity (i.e. belief about the seriousness of the consequences resulted from getting the disease), perceived benefit (i.e. belief in the efficacy of the advised actions to reduce the risk or seriousness of the disease threat), perceived barrier (i.e. belief about the tangible and psychological costs of the advised actions), and cue-to-action (i.e. the intensity of the cue that triggers the advised actions; Rosenstock, 1974). In addition to the HIV intervention, the HBM has been found to be suitable for designing and/or evaluating various health interventions in a community setting such as accident prevention (Cao, Chen, & Wang, 2014), influenza vaccination (Wu, Lau, Ma, & Lau, 2015), addiction control (Mantler, 2013; Tong, Chen, & Wu, 2019), and fertility control (Eisen, Zellman, & McAlister, 1992). Seeing the potential utility of applying the HBM to preventing

COVID-19, some researchers have already offered medical staff HBM-based suggestions to mitigate the impacts of this unprecedented health challenge (Carico, Sheppard, & Thomas, 2020; Mukhtar, 2020).

Nevertheless, the applicability of the HBM to different COVID-19 precautionary behaviors has not been empirically established. The weights and relationships among HBM factors may vary with target behaviors (Abraham & Sheeran, 2005). Past studies have also shown that some HBM factors may be more promising than others in HBM-based interventions (Jones, Smith, & Llewellyn, 2014; LaBrosse & Albrecht, 2013). Testing the applicability of the HBM has great practical significance because it can inform governments and relevant departments of proper intervention strategies (Tola et al., 2016). Therefore, the first aim of the study was to evaluate the applicability of the HBM to adherence to COVID-19 precautionary measures.

While the HBM deals with specific beliefs related to the target disease/behavior, the role of generalised beliefs about the social world (i.e. social axioms) may also influence one's adherence to precautionary measures. A group of cross-cultural psychologists has identified five social axioms (i.e. social cynicism, reward for application, social complexity, fate control, and religiosity), which are universal generalised beliefs about oneself and the social and physical environments, or the spiritual world, across more than 40 societies (Bond, Leung, Au, Tong, & Chemonges-Nielson, 2004a; Bond, Leung, Au, Tong, de Carrasquel, et al., 2004b). These generalised beliefs help explain different types of human behaviors in different cultures (Bond et al., 2004a; Leung & Bond, 2009), not only providing guidance to human actions, including health and safety behaviors (Dincă & Iliescu, 2009; Leung & Bond, 2009), but also contributing to understanding laypeople's nomological network of clinical models through predicting perceived causes and cures of psychiatric symptoms (Chen & Bond, 2012). Additionally, social axioms are found to make unique contributions over personal characteristics in behaviors involving interactive processes (e.g. self-expressive behaviors conducted in privacy and anonymity; Kurman, 2011), which may be relevant to many COVID-19 precautionary behaviors. Unfortunately, the roles of social axioms in illness-preventive behaviors are not established due to a lack of empirical studies. The second aim of the study was to evaluate whether social axioms influence adherence to COVID-19 precautionary measures.

Given that the social axioms are orthogonal, the five generalised beliefs can be used either in full or in part (Bond et al., 2004b; Zhou, Leung, & Bond, 2009). In this study, we particularly focus on the roles of social cynicism (i.e. negative views of human nature, biases against some social groups, and mistrust in social institutions) and reward for application (i.e. beliefs that the investment of effort and resources will bring positive outcomes; Bond, Leung, Au, Tong, de Carrasquel, et al., 2004b). These two social axioms were suggested to be related to the self-regulatory process (Hui & Bond, 2010), while reward for application was also related to active coping and adjustment (Safdar, Lewis, & Daneshpour,

2006). Although no empirical study has yet tested the relationship between social axioms and precautionary behaviors against a pandemic, we expect social cynicism to have a negative association with adherence to COVID-19 precautionary behaviors because a higher level of social cynicism has been found to be associated with a lower level of self-regulation and a higher tendency to distrust authorities that provide health guidance (Hui & Bond, 2010; Singelis, Hubbard, Her, & An, 2003). On the other hand, reward for application is expected to have a positive association with adherence to COVID-19 precautionary measures because stronger beliefs in positive outcomes were associated with effort, better coping, and the tendency to try harder after unsuccessful experiences (Singelis et al., 2003).

In summary, the current study aimed at evaluating the applicability of specific HBM beliefs and generalised beliefs (i.e. social axioms) to understanding the general public's adherence to COVID-19 precautionary measures in Macao, China. Macao has the highest population density in the world, with a population of around 696,100 (Direcção dos Serviços de Estatística e Censos, 2020) in a landmass of 32.9 square kilometers. By the end of May 2020, the total number of confirmed COVID-19 cases in Macao was 45, with zero mortality (Centro de Controlo e Prevenção da Doença, 2020a). To the best of our knowledge, no empirical study has tested the roles of all five HBM factors together with social axioms concerning precautionary behaviors against a pandemic, not to mention with a probability community sample. The findings of the present study may shed light on formulating promotional strategies to enhance behavioral adherence to COVID-19 precautionary measures.

METHODS

Respondents and Procedures

A telephone survey, with two-step stratified random sampling, was designed to acquire a representative sample of the local adult Chinese. The first step was a random selection of units of households from the latest residential phonebook of Macao, which was followed by the second step, a random selection of one eligible respondent within the chosen household based on the last-birthday rule—the household member who most recently had his or her birthday was selected (Gaziano, 2008). The inclusion rule was both genders, local adult residents (18 years old or above), and with the ability to understand and speak Cantonese or Mandarin Chinese. Each chosen respondent was invited to voluntarily participate in the telephone survey with a briefing by trained research assistants on the nature of the study and their rights upon participation. Formal interviews for survey data collection, without monetary incentives, were only conducted with

those who gave their oral consent to participate. Prior ethical approval for this study was obtained from the affiliated university of the first author(s).

A probability sample of 616 local Chinese adults in Macao (39.1% men, 95% CI [35.2%, 43.0%]; 60.9% women, 95% CI [57.0%, 64.8%]) was solicited through the telephone survey conducted in April 2020. Each interview lasted for an average of 16.52 min. The cooperation rate, the percentage of all cases interviewed versus all eligible respondents ever contacted, was 89.9 per cent according to the calculation method proposed by the American Association for Public Opinion Research (2016). The average age of the respondents was 41.70 years old (SD = 16.28; range = 18 to 87 years) and most of them had received education at the junior (12.8%), senior (25.6%), or tertiary (51.9%) level. About 63.0 per cent of the respondents had a full- or part- time job and the remainder were students (13.3%), retired (12.7%), homemakers (7.0%), unemployed (3.2%), or others (0.8%).

MEASURES

Adherence to COVID-19 Precautionary Measures

In line with the advice of the World Health Organization (2020) and the Macao government (Centro de Controlo e Prevenção da Doença, 2020b), our study assessed six major COVID-19 precautionary behaviors, namely proper hand washing (i.e. use solid or liquid soap to wash hands), face mask wearing (i.e. wear a face mask in public places), social distancing (i.e. keep a one-meter distance from others in public places), avoiding touching one's eyes, nose, and mouth (i.e. avoid touching nose, mouth, and eyes before proper handwashing; hereinafter *avoiding touching face*), proper toilet flushing (i.e. use the toilet lid to cover the toilet seat before flushing—a government recommendation based on early COVID-19 advice from Hong Kong; Centro de Coremaker de Contingência do Novo Tipo de Coronavírus, 2020), and carrying hand sanitiser when going out (hereinafter *carrying hand sanitiser*). Respondents were prompted to report their past-week adherence to each of the COVID-19 precautionary measures (e.g. "How often did you wear a face mask in public places last week?"). All questions were rated on a 5-point Likert scale from 1 = *never* to 5 = *always*.

HBM Factors of COVID-19

HBM items were adapted from past HBM studies on Chinese populations (Tong et al., 2019; Wang, Wu, & Lau, 2016).

(1) *Perceived Susceptibility to COVID-19* (*Susceptibility* for short) was assessed by a single item: "I am very likely to have COVID-19"; (2) *Perceived Severity of COVID-19* (*Severity* for short) was assessed by six items (e.g. "The

consequences of COVID-19 would be severe or even fatal for me"), with a Cronbach's alpha of .79; (3) *Perceived Benefit of Adherence to COVID-19 Precautionary Measures* (*Benefit* for short) involved three items (e.g. "Adherence to COVID-19 precautionary measures recommended by the government reduces the chances of having COVID-19") and displayed a Cronbach's alpha of .89; (4) *Perceived Barrier for Adherence to COVID-19 Precautionary Measures* (*Barrier* for short) contained six items (e.g. "Adherence to COVID-19 precautionary measures recommended by the government disrupts your daily life"), with a Cronbach's alpha of .74; and (5) *Cue-to-action for Adherence to COVID-19 Precautionary Measures* (*Cue-to-action* for short) was composed of eight items and focused on external cues (e.g. "How often do you receive information from public media about COVID-19 precautionary measures recommended by the government?"), with a Cronbach's alpha of .68.

All of the constructs adopted a 5-point Likert scale from 1 = *strongly disagree* to 5 = *strongly agree*, except that a 5-point Likert scale of frequency was designed for cue-to-action (1 = *never*, 5 = *always*). A scale score was computed for each construct by averaging the scores of all the items involved in the score. A higher scale score represented a higher level of the corresponding factor.

Social Axioms

Social cynicism and reward for application were assessed by two eight-item subscales of the Social Axioms Survey (Leung et al., 2012) on a 5-point Likert scale (1 = *strongly disbelieve*, 5 = *strongly believe*). Social cynicism evaluates to what extent respondents believe human nature and the social world will produce negative consequences (e.g. "People create hurdles to prevent others from succeeding."). Reward for application entails the belief that positive outcomes can be achieved as a result of people's use of effort, knowledge, careful planning, and other resources (e.g. "One will succeed if he/she really tries."). A higher subscale score represented a higher level of the corresponding social axiom construct. The internal reliability of social cynicism and reward for application was .79 and .88, respectively.

Demographic Variables

Demographic items included gender, age, educational attainment (six levels from no formal education to tertiary level and each level was converted to *years of education* for analysis), and work status (six categories of employed [full- or part-time], unemployed, retired, student, homemaker, and others). Respondents also responded to whether they had ever had COVID-19.

Statistical Analysis

We first conducted preliminary analyses in SPSS 25.0 to explore the extent of adherence to each of the precautionary measures in order to identify the prevalence of strong adherence across various precautionary measures. Second, associations among adherence, HBM factors, and social axioms were examined with Pearson's *r* for bivariate correlation in SPSS 25.0 and then with one multivariate regression that included the adherence to all six types of precautionary measures altogether to test the hypothesised multivariate association in Mplus 7.3. The demographic effects of gender, age, and years of education were controlled for in the multivariate regression. Because none of the respondents reported experience of the COVID-19 infection, this indicator showed no variance and hence has not been included in the analysis. The missing values were handled by a robust form of Full Information Maximum Likelihood, maximum likelihood estimation with robust standard errors (MLR), which also does not assume multivariate normality; however, the cases with missing values at X-position were excluded from the model by default of MLR.

RESULTS

Preliminary Analyses

None of the respondents reported experience of having COVID-19. The respondents' adherence to each of the COVID-19 precautionary measures was considered as strong if a practice frequency of "often" (4 points on the 5-point scale) or above was reported. Most respondents showed strong adherence to face mask wearing and proper handwashing (96.4% and 79.1%, respectively), while over half often engaged in proper toilet flushing (72.6%), avoiding touching the face (63.6%), and carrying hand sanitiser (59.8%). However, only 42.3 per cent reported strong adherence to social distancing.

Associations among Adherence, HBM Factors, and Social Axioms

Table 1 demonstrates the bivariate associations among adherence to COVID-19 precautionary measures, HBM factors, and two social axioms. Following the guideline of Cohen (1988), a bivariate Pearson's $r < .10$, the small effect size, was not further interpreted, while a significance level of .01 provides a more stringent result than that of a significance level of .05. For HBM factors, perceived benefit displayed a positive association with adherence to proper handwashing, face mask wearing, and social distancing ($r = .12$ to $.15$, $p < .01$), while perceived barrier showed a negative association with adherence to proper

TABLE 1
Bivariate Correlations among Adherence, HBM Factors, and Social Axioms (N = 616)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Adherence													
1. Proper hand washing	1												
2. Face mask wearing	.23***	1											
3. Social distancing	−.01	.11**	1										
4. Avoiding touching face	.10*	.22***	.03	1									
5. Proper toilet flushing	.17***	.16***	.15***	.13**	1								
6. Carrying hand sanitiser	.18***	12**	.12**	.07	.30***	1							
HBM factors													
7. Susceptibility	−.02	−.04	.01	−.03	.06	.001	1						
8. Severity	.06	.07	−.03	.04	.18***	.01	.24***	1					
9. Benefit	.14**	.15***	.12**	.09†	.09†	.09†	−.12**	.16***	1				
10. Barrier	−.10*	−.11**	.02	−.18***	−.09†	−.09†	.26***	.11**	−.11**	1			
11. Cue-to-action	.07	.07	.11**	−.03	.08†	.17***	.09†	.20***	.22***	.10*	1		
Social axioms													
12. Social cynicism	−.14***	−.20***	−.04	−.19***	−.08†	−.11**	.26***	.06	−.14**	.26***	−.08	1	
13. Reward for application	.05	.12**	.12**	.06	.15***	.16***	−.10*	.07	.21***	−13**	.06	−.02	1
M (*SD*)	4.01 (0.91)	4.83 (0.51)	3.30 (1.13)	3.73 (1.07)	3.91 (1.24)	3.53 (1.38)	2.55 (1.29)	3.80 (0.68)	4.33 (0.57)	2.60 (0.71)	3.44 (0.62)	2.85, (0.68)	3.86 (0.64)

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

† $p < .05$ but r value does not reach a small effect size (lower than 0.10).

TABLE 2
Multivariate Regression of Adherence in Relation to the HBM and Social Axioms Constructs (N = 575)

	1. Proper handwashing		*2. Face mask wearing*		*3. Social distancing*	
	β *[95% CI]*	p	β *[95% CI]*	p	β *[95% CI]*	P
Susceptibility	0.03 [−0.068, 0.126]	.56	0.02[−0.053, 0.086]	.64	0.03 [−0.061, 0.118]	.54
Severity	0.02 [−0.072, 0.114]	.66	0.06 [−0.040, 0.158]	.24	−0.07 [−0.172, 0.023]	.13
Benefit	0.11 [0.022, 0.202]	.02	0.08 [0.015, 0.154]	.02	0.09 [0.001, 0.182]	.047
Barrier	−0.08 [−0.160, 0.007]	.07	−0.04 [−0.120, 0.035]	.28	0.05 [−0.051, 0.142]	.35
Cue−to-action	0.05 [−0.045, 0.145]	.30	0.02 [−0.073, 0.103]	.74	0.10 [0.006, 0.202]	.04
Social cynicism	−0.10 [−0.190, −0.005]	.04	−0.17 [−0.252, −0.080]	<.001	−0.03 [−0.127, 0.068]	.56
Reward for application	0.01 [−0.090, 0.116]	.80	0.11 [−0.007, 0.220]	.07	0.11 [0.014, 0.210]	.03
Gender	0.07 [−0.014, 0.148]	.11	−0.02 [−0.093, 0.060]	.68	−0.02 [−0.104, 0.059]	.59
Age	−0.04 [−0.150, 0.063]	.42	−0.04 [−0.133, 0.066]	.51	0.04 [−0.068, 0.147]	.47
Years of education	−0.003 [−0.110, 0.105]	.96	−0.05 [−0.150, 0.051]	.34	0.03 [−0.072, 0.136]	.54
	R^2 = 0.049, p = .01		R^2 = 0.065, p = .005		R^2 = 0.045, p = .02	
	4. Avoiding touching face		**5. Proper toilet flushing**		**6. Carrying hand sanitiser**	
	***β* [95% CI]**	***p***	***β* [95% CI]**	***p***	***β* [95% CI]**	***P***
Susceptibility	0.03 [−0.067, 0.121]	.57	0.07[−0.19, 0.154]	.13	0.06 [−0.035, 0.145]	.23
Severity	0.08 [−0.007, 0.169]	.07	0.13 [0.034, 0.226]	.01	−0.04 [−0.128, 0.057]	.45
Benefit	0.03 [−0.056, 0.112]	.51	0.05 [0.042, 0.136]	.30	0.04 [−0.054, 0.132]	.41
Barrier	−0.11 [−0.200, −0.029]	.01	−0.09 [−0.169, −0.001]	.048	−0.06 [−0.154, 0.030]	.19
Cue-to-action	−0.05 [−0.145, 0.042]	.28	0.02 [−0.081, 0.115]	.73	0.13 [0.032, 0.229]	.01
Social cynicism	−0.18 [−0.265, −0.100]	<.001	−0.06 [−0.156, 0.036]	.22	−0.07 [−0.158, 0.021]	.13
Reward for application	0.001 [−0.090, 0.091]	.99	0.12 [0.030, 0.215]	.01	0.15 [0.064, 0.242]	.001
Gender	0.06 [−0.016, 0.143]	.12	0.10 [0.019, 0.179]	.02	0.14 [0.058, 0.214]	.001
Age	0.08 [−0.035, 0.186]	.18	−0.04 [−0.143, 0.060]	.42	−0.12 [−0.227, −0.010]	.03

TABLE 2 *(CONTINUED)*

	1. Proper handwashing		*2. Face mask wearing*		*3. Social distancing*	
	β *[95% CI]*	p	β *[95% CI]*	p	β *[95% CI]*	P
Years of education	−0.02 [−0.118, 0.079] R^2 = 0.076, p = .001	.70	0.003 [−0.092, 0.098] R^2 = 0.074, p = .001	.94	−0.01 [−0.105, 0.091] R^2 = 0.093, p < .001	.89

Note: The missing values were handled by maximum likelihood estimation with robust standard errors (MLR) in the model while 41 cases with missing values at X-position were excluded from the analysis by default of MLR.
HBM, Health Belief Model.

handwashing, face mask wearing, avoiding touching face ($r = -.10$ to $-.18$, $p < .05$ to $< .001$). Cue-to-action was positively associated with two precautionary behaviors, including social distancing and carrying hand sanitiser ($r = .11$ and $.17$, $p < .01$ and $< .001$); whereas perceived severity was positively associated with proper toilet flushing ($r = .18$, $p < .001$). For two social axioms, social cynicism was negatively associated with proper handwashing, face mask wearing, avoiding touching face, and carrying hand sanitiser ($r = -.11$ to $-.20$, $p < .01$ to $< .001$); in contrast, reward for application was positively associated with face mask wearing, social distancing, proper toilet flushing, and carrying hand sanitiser ($r = .12$ to $.16$, $p < .01$ to $< .001$).

The multivariate associations between adherence to COVID-19 precautionary measures and HBM/social beliefs were further explored with the multivariate regression analysis, in which gender, age, and years of education were controlled for (see Table 2). Except for perceived susceptibility showing a non-significant association with all six precautionary behaviors, the other four HBM factors and two social axioms all demonstrated significant associations with adherence to at least one precautionary measure and in the expected directions. Specifically, perceived benefit was positively associated with proper handwashing, face mask wearing, and social distancing ($\beta = 0.08$ to 0.11, $p < .05$), while perceived barrier was negatively associated with avoiding touching face as well as proper toilet flushing ($\beta = -0.09$ to -0.11, $p < .05$). Cue-to-action was positively associated with carrying hand sanitiser and social distancing ($\beta = 0.10$ to 0.13, $p < .05$), whereas perceived severity was positively associated with proper toilet flushing ($\beta = 0.13$, $p = .01$). As for the two social axioms, social cynicism was negatively associated with proper handwashing, avoiding touching face, and face mask wearing ($\beta = -0.10$ to -0.18, $p < .05$), while reward for application was positively associated with proper toilet flushing, carrying hand sanitiser, and social distancing ($\beta = 0.11$ to 0.12, $p < .05$).

DISCUSSION

The present study examined residents' adherence to six types of COVID-19 precautionary measures in Macao, where none of these measures were enforced by law and no penalty was imposed for noncompliance. Among the six precautionary measures, we found that face mask wearing in public places was most likely to be adhered to (i.e. 96.4% *often* or *always*), followed by proper handwashing (i.e. 79.1% *often* or *always*). The findings were consistent with similar studies in East Asia (e.g. Lee & You, 2020) demonstrating that people showed strong adherence to personal hygiene measures. A plausible underlying mechanism may lie in Asian health beliefs regarding these personal hygiene practices. Wada et al. (2012) argued that face mask wearing in public places was common in some Asian countries, especially during influenza seasons, because people believe that it helps prevent respiratory infections; in addition, they also showed

that face mask wearing was associated with other positive health behaviors, such as handwashing. Their arguments were consistent with our findings that perceived benefit was positively related to these COVID-19 precautionary measures. Nevertheless, one should note that social cynicism was negatively related to proper hand washing and face mask wearing in the present study; it may suggest that people who had a negative world view and mistrust in social institutions were less likely to follow the precautionary measures recommended by authorities. Further study may investigate whether the social cynics were more receptive to misinformation or conspiracy theories against practices proposed by the authorities.

Social distancing, protecting people from virus-carrying droplets, is another major preventive measure advocated by the World Health Organization (2020). Unfortunately, our sample showed poor adherence to it (i.e. 42.3%) despite its importance. Practicing social distancing requires effort and resources to overcome the inconvenience or social norms against it, which is particularly difficult for young people (Andrews, Foulkes, & Blakemore, 2020). There were limited empirical evidence testing factors that may influence adherence to social distancing. Our findings addressed this missing link and suggested that strategies of providing more resources through more exposure to cue-to-action (e.g. posters or government broadcasts) may promote adherence to social distancing. Additionally, we identified that those who believed that positive outcomes would follow an investment of effort and resources were more likely to adhere to social distancing. Future research may also consider including other potential factors of adherence to social distancing in addition to the HBM constructs and social axioms. For example, Andrews et al. (2020) proposed a social norm favoring social distancing, a community-level factor, that can be a promising element to enhance one's adherence to social distancing, especially for young people.

Based on our findings, adherence to different types of precautionary measures was correlated with four HBM factors (i.e. perceived severity, perceived benefit, perceived barrier, and cue-to-action) and two generalised beliefs (i.e. social cynicism and reward for application) to different extents. Similar to the findings of Jones et al. (2014), the HBM as a whole may improve adherence, but the specific HBM factors that work best may vary across behaviors. Consistent with our findings concerning perceived severity, Harper et al. (2020) reported a correlation between risk perception and COVID-19-related behavioral variations. Interventions, targeting perceived severity, typically involve providing information on risk factors and the health consequences (e.g. Jones, Jones, & Katz, 1988; Kelly, Zyzanski, & Alemagno, 1991). Weinstein and Klein (1995) argued that people, particularly in the younger age groups, may be too optimistic and thus would undermine the effectiveness of the intervention. The solution proposed by Weinstein (1983) was simple; that is, to reduce excessive optimism by providing additional information (e.g. figures on mortality) to their peers because information

linking the enactment of behaviors and specific facts about disease transmission may provide a realistic appraisal of risky behaviors.

Perceived benefit, with positive valence, and perceived barrier, with negative valence, were both related to COVID-19 precautionary behaviors in this study. Consistent with what McCaul and Wold proposed (2002), our findings suggest that perceived benefit and perceived barrier may contribute to adherence to these behaviors during the pandemic, and thus a better understanding of these two factors can be a requisite for related interventions to work. Previous studies have suggested that tailored messages can be effective in promoting the perceived benefit of health behaviors in specific target groups (e.g. McCaul & Wold, 2002; Nansel et al., 2002). Given that COVID-19 is highly infectious, precautionary behaviors not only are beneficial to oneself but also can contribute to the community health as a whole. Therefore, the perception of "benefits to others" may also be promoted in related health campaigns. In addition, future campaigns are advised to take into account whether sufficient and consistent information is being provided to change the perception of barriers and inform the public of precautionary behaviors. Special attention should be paid to common barriers to health behaviors, such as side effects, inconvenience, cost, and peer pressure (Jones et al., 2014). For example, wearing a face mask may be considered as violating peer norms at the beginning of the pandemic, which may be overcome by allowing specific groups, such as young people, to take part in creating their own promotion campaigns.

As hypothesised, cue-to-action was found to be positively associated with adherence to COVID-19 precautionary measures in our study. Although Noar, Benac, and Harris's (2007) review pointed out the general effectiveness of HBM-based interventions for health promotions, intervention studies based on cue-to-action were relatively rare (Jones et al., 2014) and some past findings may not be effective in the digital era when traditional media plays a less important role, especially among young people. Further cue-to-action study concerning pandemic/epidemic prevention could focus on personalised reminders (e.g. mobile health) and workshops directed toward groups with specific needs (Cao et al., 2014; Odeny et al., 2014), such as older adults.

Generally speaking, the present study supported that the HBM can be applied to understanding individual differences in adherence to COVID-19 precautionary measures. Since the HBM assumes that people's behaviors are influenced by perceived reality, changes in their subjective health beliefs (i.e. related to the disease and corresponding preventive behaviors) via multiple means (e.g. evaluative assessment, protocol provision, and education) are the core theme of HBM-based intervention (Jones et al., 1988). Our findings have lent extra empirical support to the role of beliefs, as intrapersonal factors, on COVID-19 precautionary behaviors. In line with Noar et al.'s (2007) assertion that HBM-based interventions were generally effective for health promotions based on their review study, our findings also offered insight for the promotion of precautionary measures via

HBM-based interventions in the COVID-19 pandemic and other possible pandemics in the future, especially in the absence of any effective vaccines (Betsch, 2020; Eaton & Kalichman, 2020). However, the relatively small effect sizes of the HBM factors imply that interventions based purely on the intrapersonal level (e.g. HBM factors) alone may be insufficient to substantially influence the adherence to precautionary measures. Further studies may consider the social-ecological model (McLeroy, Bibeau, Steckler & Glanz, 1988) that incorporates not only intrapersonal-level factors like HBM but also factors at the interpersonal level (e.g. social stigma), the community level (e.g. social norms) and the societal level (e.g. community mobilisation) when designing effective interventions.

The generalised belief, also known as social axioms, of reward for application and social cynicism were also found to be associated with COVID-19 precautionary behaviors in the present study. The mechanism linking social axioms and health behavior is not well documented. While some studies have suggested that their influences on behaviors may be indirect (Liem, Hidayat, & Soemarno, 2009), other studies have shown that they have direct effects on behaviors (Bond et al., 2004a; Dincă & Iliescu, 2009; Kurman, 2011). Reward for application promotes effort exertion and favorable attitudinal reactions to striving (Zhou et al., 2009) and we also found its direct effect on practicing COVID-19 precautionary behaviors. On the other hand, social cynicism had a negative relation with precautionary behaviors, implying that a negative view toward authority or society has an undesirable influence on adherence to the precautionary measures proposed by the government. In fact, concerning COVID-19 responses or policies, there was distrust in government, misinformation perpetuated by vaccine activists, or even conspiracy beliefs referring to the pandemic as a hoax (Limaye et al., 2020). Interventions aimed at reducing social cynicism may take time to work but it may be useful to prepare people for facing potential future pandemics or accepting clinically approved vaccines. Some researchers have proposed the potential relevance of social axioms to clinical interventions, such as sensitivity to individual beliefs (Lam, Bond, Chen, & Wu, 2010), but there is no empirical test of health interventions based on social axioms by far, and thus further research is warranted. In addition, other dimensions of social axioms may also be promising for future investigations. For instance, religiosity may have a negative association with the adoption of precautionary behaviors because some of the recommended precautionary behaviors may be inconsistent with religious practices (Muhtada, 2020).

There are a few limitations of this study. First, the present investigation only considered a limited number of intrapersonal factors based on the HBM and social axioms, while factors such as personality may also contribute to our understanding. In addition, a more comprehensive picture of pandemic prevention can be further extended to the interpersonal, community, and societal levels. Indicators of exposure to COVID-19 (e.g. COVID-19 infection experience), behavioral factors (e.g. previous hygiene habits), and socioeconomic status are

worth being controlled for, especially in regions with more infections. Second, given the cross-sectional design of the present study, it is not feasible to trace the influences of beliefs on precautionary behaviors over time, nor to make any causal inferences. A longitudinal or experimental study that explores the relationship of different HBM factors or social axioms with adherence to COVID-19 precautionary measures will further improve our understanding of the effectiveness of interventions based on these beliefs. Given the varying impacts of different HBM factors and social axioms across precautionary practices, it is premature to conclude what works best for interventions, and thus future investigation is needed. The small effect size of HBM factors observed in our study may also be found in regions with few COVID-19 cases and low death rates (e.g. Taiwan and Japan), plausibly accompanied by a discovery of the limited role of susceptibility and severity, similar to our findings. In regions with more COVID-19 cases and higher death rates, the importance of different HBM factors may change and a cross-cultural study is required for further exploration. Third, there may be self-report biases (e.g. social desirability) and systematic sampling errors (e.g. failure to reach all the eligible participants of the target population) in this self-report survey, so readers are advised to take account of such limitations. Last but not least, it remains unknown how cultural factors would influence COVID-19 precautionary behaviors. Some researchers have proposed investigating different cultural dimensions, such as tightness or looseness of social norms, to understand COVID-19-related responses (Bavel et al., 2020). Although the HBM and social axioms are assumed to be valid across cultures, the weighting of each factor is not; such information can be valuable in tailoring country-specific prevention strategies.

In summary, the present study examined adherence to different COVID-19 precautionary measures among Chinese adults in a probability community sample and provided support for the hypothesised relations among HBM factors, social axioms, and adherence to COVID-19 precautionary measures. To the best of our knowledge, this is the first attempt to test whether the five HBM factors together with social axioms are related to precautionary behaviors against a pandemic. Based on the results, we have discussed the potential applications of specific health beliefs and generalised beliefs to improving the design of COVID-19 precautionary promotion.

REFERENCES

Abraham, C., & Sheeran, P. (2005). The health belief model. In M. Conner & P. Normal (Eds.), *Predicting health behavior* (2nd edn., pp. 28–80). Philadelphia, PA: Open University Press.

Abraham, C., Sheeran, P., Spears, R., & Abrams, D. (1992). Health beliefs and promotion of HIV-preventive intentions among teenagers: A Scottish perspective. *Health Psychology*, *11*(6), 363–370.

American Association for Public Opinion Research (2016). Standard definitions: Final dispositions of case codes and outcome rates for surveys, 9th edition. AAPOR.

Andrews, J.L., Foulkes, L., & Blakemore, S.-J. (2020). Peer influence in adolescence: Public-health implications for COVID-19. *Trends in Cognitive Sciences*, *24*(8), 585–587.

Bavel, J.J.V., Baicker, K., Boggio, P.S., Capraro, V., Cichocka, A., Cikara, M., … Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, *4*(5), 460–471.

Betsch, C. (2020). How behavioural science data helps mitigate the COVID-19 crisis. *Nature Human Behaviour*, *4*(5), 438.

Bond, M.H., Leung, K., Au, A., Tong, K.-K., & Chemonges-Nielson, Z. (2004a). Combining social axioms with values in predicting social behaviours. *European Journal of Personality*, *18*(3), 177–191.

Bond, M.H., Leung, K., Au, A., Tong, K.-K., de Carrasquel, S.R., Murakami, F., … Lewis, J.R. (2004b). Culture-level dimensions of social axioms and their correlates across 41 cultures. *Journal of Cross-Cultural Psychology*, *35*(5), 548–570.

Buldeo, P., & Gilbert, L. (2015). Exploring the health belief model and first-year students' responses to HIV/AIDS and VCT at a South African university. *African Journal of AIDS Research*, *14*(3), 209–218.

Cao, Z.-J., Chen, Y., & Wang, S.-M. (2014). Health belief model based evaluation of school health education programme for injury prevention among high school students in the community context. *BMC Public Health*, *14*(1), 26.

Carico, R.R., Sheppard, J., & Thomas, C.B. (2020). Community pharmacists and communication in the time of COVID-19: Applying the health belief model. *Research in Social and Administrative Pharmacy*. https://doi.org/10.1016/j.sapharm.2020.03.017

Centro de Controlo e Prevenção da Doença (2020a). Pagina Electrónica Especial Contra Epidemias Confluência. Retrieved from: https://www.ssm.gov.mo/apps1/PreventCOVID-19/pt.aspx#clg17458.

Centro de Controlo e Prevenção da Doença (2020b). Pagina Electrónica Especial Contra Epidemias Educação em Saúde. Retrieved from: https://www.ssm.gov.mo/apps1/PreventCOVID-19/en.aspx#clg17668.

Coordenação and de Contingência do Novo Tipo de Coronavírus (2020). Tipo de Coronavírus apela à manutenção dos canais de drenagem em habitações. Retrieved from: https://www.gov.mo/pt/noticias/221753/.

Chen, S.X., & Bond, M.H. (2012). Lay beliefs about psychological and social problems among adolescents: Motivational and cognitive antecedents. *Journal of Applied Social Psychology*, *42*, 170–194.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd edn.). Hillsdale, NJ: Erlbaum Associates.

Dincă, M., & Iliescu, D. (2009). Linking social axioms with behavioral indicators and personality in Romania. In K. Leung & M.H. Bond (Eds.), *Psychological aspects of social axioms: Understanding global belief systems* (pp. 145–162). New York: Springer.

Direcção dos Serviços de Estatística e Censos (2020). Estimativas da população. Retrieved from: https://www.dsec.gov.mo/ts/#!/step2/PredefinedReport/pt-PT/1.

Eaton, L.A., & Kalichman, S.C. (2020). Social and behavioral health responses to COVID-19: Lessons learned from four decades of an HIV pandemic. *Journal of Behavioral Medicine*, *43*(3), 341–345.

Eisen, M., Zellman, G.L., & McAlister, A.L. (1992). A health belief model-social learning theory approach to adolescents' fertility control: Findings from a controlled field trial. *Health Education Quarterly*, *19*(2), 249–262.

Gaziano, C. (2008). Last-birthday selection. In P.J. Lavrakas (Ed.), *Encyclopedia of survey research methods*, Vol. *1* (pp. 417–418). Thousand Oaks, CA: SAGE Publications.

Harper, C.A., Satchell, L.P., Fido, D., & Latzman, R.D. (2020). Functional fear predicts public health compliance in the COVID-19 pandemic. *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-020-00281-5

Hui, C.-M., & Bond, M.H. (2010). Relationship between social axioms and subjective well-being: The role of self-regulation. *Journal of Psychology in Chinese Societies*, *11*, 1–24.

Jones, C.J., Smith, H., & Llewellyn, C. (2014). Evaluating the effectiveness of health belief model interventions in improving adherence: A systematic review. *Health Psychology Review*, *8*(3), 253–269.

Jones, S.L., Jones, P.K., & Katz, J. (1988). Health belief model intervention to increase compliance with emergency department patients. *Medical Care*, *26*(12), 1172–1184.

Kelly, R.B., Zyzanski, S.J., & Alemagno, S.A. (1991). Prediction of motivation and behavior change following health promotion: Role of health beliefs, social support, and self-efficacy. *Social Science & Medicine*, *32*(3), 311–320.

Kurman, J. (2011). What I do and what I think they would do: Social axioms and behaviour. *European Journal of Personality*, *25*(6), 410–423.

LaBrosse, L., & Albrecht, J.A. (2013). Pilot intervention with adolescents to increase knowledge and consumption of folate-rich foods based on the Health Belief Model. *International Journal of Consumer Studies*, *37*(3), 271–278.

Lam, B.C.P., Bond, M.H., Chen, S.X., & Wu, W.C.H. (2010). Worldviews and individual vulnerability to suicide: The role of social axioms. *European Journal of Personality*, *24*(7), 602–622.

Lee, M., & You, M. (2020). Psychological and behavioral responses in South Korea during the early stages of Coronavirus Disease 2019 (COVID-19). *International Journal of Environmental Research and Public Health*, *17*(9), 2977.

Leung, K., & Bond, M.H. (Eds.) (2009). *Psychological aspects of social axioms*. New York: Springer.

Leung, K., Lam, B.C.P., Bond, M.H., Conway, L.G., Gornick, L.J., Amponsah, B., … Zhou, F. (2012). Developing and evaluating the Social Axioms Survey in eleven countries: Its relationship with the five-factor model of personality. *Journal of Cross-Cultural Psychology*, *43*(5), 833–857.

Liem, A.D., Hidayat, S.S., & Soemarno, S. (2009). Do general beliefs predict specific behavioral intentions in Indonesia? The role of social axioms within the theory of planned behavior. In K. Leung & M.H. Bond (Eds.), *Psychological aspects of social axioms. International and Cultural Psychology* (pp. 217–238). New York: Springer.

Limaye, R.J., Sauer, M., Ali, J., Bernstein, J., Wahl, B., Barnhill, A., & Labrique, A. (2020). Building trust while influencing online COVID-19 content in the social media world. *The Lancet Digital Health*, *2*(6), e277–e278.

Lin, P., Simoni, J.M., & Zemon, V. (2005). The health belief model, sexual behaviors, and HIV risk among Taiwanese immigrants. *AIDS Education and Prevention*, *17*(5), 469–483.

Lux, K.M., & Petosa, R. (1994). Using the health belief model to predict safer sex intentions of incarcerated youth. *Health Education Quarterly*, *21*(4), 487–497.

Maier, B.F., & Brockmann, D. (2020). Effective containment explains subexponential growth in recent confirmed COVID-19 cases in China. *Science*, *368*(6492), 742–746.

Mantler, T. (2013). A systematic review of smoking youths' perceptions of addiction and health risks associated with smoking: Utilizing the framework of the health belief model. *Addiction Research & Theory*, *21*(4), 306–317.

McCaul, K.D., & Wold, K.S. (2002). The effects of mailed reminders and tailored messages on mammography screening. *Journal of Community Health*, *27*(3), 181–190.

McLeroy, K.R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education & Behavior*, *15*(4), 351–377.

Muhtada, D. (2020). Religion and COVID-19 mitigation. The Jakarta Post. Retrieved from: https://www.thejakartapost.com/academia/2020/03/26/religion-and-covid-19-mitigation.html.

Mukhtar, S. (2020). Mental health and emotional impact of COVID-19: Applying Health Belief Model for medical staff to general public of Pakistan. *Brain, Behavior, and Immunity*, *S0889–1591*(0820), 30463.

Nansel, T.R., Weaver, N., Donlin, M., Jacobsen, H., Kreuter, M.W., & Simons-Morton, B. (2002). Baby, be safe: The effect of tailored communications for pediatric injury prevention provided in a primary care setting. *Patient Education and Counseling*, *46*(3), 175–190.

Noar, S.M., Benac, C.N., & Harris, M.S. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin*, *133*(4), 673–693.

Nöthling, J., & Kagee, A. (2013). Acceptability of routine HIV counselling and testing among a sample of South African students: Testing the Health Belief Model. *African Journal of AIDS Research*, *12*(3), 141–150.

Odeny, T.A., Newman, M., Bukusi, E.A., McClelland, R.S., Cohen, C.R., & Camlin, C.S. (2014). Developing content for a mHealth intervention to promote postpartum retention in prevention of mother-to-child HIV transmission programs and early infant diagnosis of HIV: A qualitative study. *PLoS One*, *9*(9), e106383.

Rosenstock, I.M. (1974). Historical origins of the health belief model. *Health Education Monographs*, *2*(4), 328–335.

Safdar, S., Lewis, J.R., & Daneshpour, M. (2006). Social axioms in Iran and Canada: Intercultural contact, coping and adjustment. *Asian Journal of Social Psychology*, *9*(2), 123–131.

Singelis, T.M., Hubbard, C., Her, P., & An, S. (2003). Convergent validation of the Social Axioms Survey. *Personality and Individual Differences*, *34*(2), 269–282.

Tola, H.H., Shojaeizadeh, D., Tol, A., Garmaroudi, G., Yekaninejad, M.S., Kebede, A., ... Klinkenberg, E. (2016). Psychological and educational intervention to improve

tuberculosis treatment adherence in Ethiopia based on health belief model: A cluster randomized control trial. *PLoS One*, *11*(5), e0155147.

Tong, K.-K., Chen, J.H., & Wu, A.M.S. (2019). Application of health belief model to practice of responsible gambling. *Journal of Gambling Studies*, *35*(3), 1047–1062.

Wada, K., Oka-Ezoe, K., & Smith, D.R. (2012). Wearing face masks in public during the influenza season may reflect other positive hygiene practices in Japan. *BMC Public Health*, *12*(1), 1065.

Wang, Y., Wu, A.M.S., & Lau, J.T.F. (2016). The health belief model and number of peers with internet addiction as inter-related factors of Internet addiction among secondary school students in Hong Kong. *BMC Public Health*, *16*(1), 272.

Weinstein, N.D. (1983). Reducing unrealistic optimism about illness susceptibility. *Health Psychology*, *2*(1), 11–20.

Weinstein, N.D., & Klein, W.M. (1995). Resistance of personal risk perceptions to debiasing interventions. *Health Psychology*, *14*(2), 132–140.

World Health Organization (2020). Coronavirus disease (COVID-19) advice for the public. Retrieved from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public.

Wu, A.M.S., Lau, J.T.F., Ma, Y.L., & Lau, M.M.C. (2015). Prevalence and associated factors of seasonal influenza vaccination among 24- to 59-month-old children in Hong Kong. *Vaccine*, *33*(30), 3556–3561.

Zhao, J., Song, F., Ren, S., Wang, Y., Wang, L., Liu, W., … Sun, Y. (2012). Predictors of condom use behaviors based on the Health Belief Model (HBM) among female sex workers: A cross-sectional study in Hubei Province, China. *PLoS ONE*, *7*(11), e49542.

Zhou, F., Leung, K., & Bond, M.H. (2009). Social axioms and achievement across cultures: The influence of reward for application and fate control. *Learning and Individual Differences*, *19*(3), 366–371.