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Levels and factors of social and physical distancing based on the Theory of Planned Behavior during the COVID-19 pandemic among Chinese adults

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Abstract

Social and physical distancing is important in controlling the COVID-19 pandemic and it impacts people's financial/social well-being tremendously. This study tested the application of the Theory of Planned Behaviors (TPB) to three types of social/physical distancing indicators (i.e., the number of close physical contacts on a single day in public venues, the frequencies of avoiding social gathering, and the levels of physical distancing in public venues). A population-based random telephone survey interviewed 300 Hong Kong Chinese adults in April 2020 when gatherings involving >4 people were banned. The participants on average made 15.3 close physical contacts (<1.5 m and for >3 min) in a day (5.0 in public transportation). About 80% practiced social distancing (avoided/reduced social gatherings) and physical distancing in public spaces (e.g., avoidance of going out, visiting crowded places, and gatherings of >4 people) but only 35.4% avoided using public transportations. Positive but not negative attitudes (inconvenience and lack of necessity), perceived behavioral control, and subjective norm were significantly associated with the three social/physical distancing outcomes. The data suggest that the levels of social/physical distancing were relatively high in the Hong Kong general population, and it, in general, supports the application of TPB to understand factors of social distancing for preventing COVID-19. Health promotion should take the findings into account. Furthermore, cross-cultural and time-series studies are warranted to compare the levels of social/physical distancing across countries and further explore their effectiveness in controlling the COVID-19 pandemic.

Keywords

COVID-19, Social distancing, Physical distancing, Theory of Planned Behaviors; China

Implications

Practice: Community-based interventions or social marketing programs should be planned and implemented to improve social distancing behaviors via modifications of positive attitudes, subjective norms, and perceived behavioral control to contain COVID-19.

Policy: Policymakers are recommended to monitor changes in the levels of the three domains of social/physical distancing in the general population over time and adjust/evaluate related policies.

Research: Future cross-cultural and time-series studies are recommended to compare the levels and factors of social distancing; randomized controlled trials are recommended to create evidence-based programs to enhance effectively social distancing.

INTRODUCTION

Social distancing comprises comprehensive public health practices that prevent the spread of emerging infectious disease (e.g., severe acute respiratory syndrome [SARS] and swine flu [H1N1]) by maintaining a physical distance between people and hence reducing the number of times people come into close contacts with each other [1, 2]. A review of observational and simulation studies reported its effectiveness in reducing H1N1 and seasonal flu transmissions [3]. It is especially important for the prevention of coronavirus disease 2019 (COVID-19) which is transmittable via asymptomatic infected persons [4].

It is unprecedented that many governments implemented social distancing as legal measures at national levels. During the COVID-19 pandemic, many countries (e.g., China, Italy, France, Spain, and the USA) enforced related measures such as suspended classes, stay-at-home orders, closing bars and restaurants, working from home policies, and banned mass gatherings [1, 2, 5, 6]. Although such measures are meant to be temporary and have been constantly reviewed according to available epidemiological data, they reduce productivity and social interactions and cause mental health problems [7].

Social distancing for controlling COVID-19 needs to be seen as a combination of governmental measures and individual responses. Unfortunately, there are seriously split views within governments and countries about the necessity, intensity, and duration of implementing/sustaining such social distancing measures [6, 8]. There is a lot of leeway for personal decisions as governmental measures cannot

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be completely enforced, nor prescribe rules for all circumstances of social contacts. Thus, effective social distancing needs to combine individuals' compliance and voluntary choices with governmental measures. Just like other preventive behaviors, effective health promotion on social distancing requires an understanding of its determinants.

Despite the significance, there seems neither well-developed definition nor measurement of social distancing. One of the present study's aims is to refine the scope and measurements of social distancing, which represents a group of volitional and non-volitional behaviors. WHO suggests the term "physical distancing" instead of "social distancing," as it is the physical distance that prevents transmission while people can remain socially connected. In this study, social distancing included physical distancing and involves three inter-related dimensions. The first dimension is about the daily number of people being contacted within a distance of 1–2 m. Such a factual account of physical distancing may either be intentional or non-intentional, and involve or not involve social interactions. The measure reflects the "objective" risk level gauged by the degree of social distancing. The second dimension confines to social distancing only; it was above volitional avoidance of social gatherings/meetings (e.g., avoid social gatherings). The third dimension refers to the volitional practice of physical distancing, that is, practices taken to minimize close physical contacts with others in public venues (e.g., keeping a physical distance from people). This study hence assessed social/physical distancing comprehensively and innovatively. It has devised new measurements for all these three dimensions of social distancing and investigated their associated factors.

This study used the Theory of Planned Behavior (TPB), which is highly relevant to investigation of social distancing, as the conceptual framework. It postulates that attitude, subjective norm (support from significant others), and perceived behavioral control related to a health-related behavior would affect one's intention to perform a behavior, which in turn determines actual performance of the behavior [9]. The TPB has been applied to understand factors of preventive behaviors related to SARS [10] and the behavioral intention to take up H1N1-related vaccines [11]. Such factors are applicable to the study of social distancing related to COVID-19. First, social distancing certainly has its pros (e.g., protection and ease of mind) and cons (e.g., harms to the economy and social relationships); this study thus looked at both positive and negative attitudes of social distancing. Second, since social distancing very often involves inter-personal relationship, how one's significant others view and practice social distancing would determine his/her social distancing outcomes. Regarding COVID-19, some general populations showed mixed attitudes and subjective norm related to social distancing [12]; this study thus included these two potential factors of social distancing. Third, the strength of perceived behavioral control depends on specific types of social distancing (e.g., seeing a friend versus using public transportation); we thus develop a scale to assess the ability to exercise social/physical distancing under various circumstances. It is noteworthy that no research has applied behavioral health theories (e.g., TPB) to investigate social distancing. The present study hence filled out the gap.

This study was conducted in Hong Kong where no lockdown was conducted, although class suspension, closure of governmental services, and boundary restrictions were exercised since January 26, 2020. Visitors were tested for COVID-19 and self-quarantined or being mandatorily quarantined for 14 days. Facemask wearing becomes universal although no law requires the practice [13]. People have never been prohibited from going out; only limited types of venues (e.g., fitness centers, cinemas, and bars) were shut down; most shops and all transportation remained open. Social distancing measures were introduced; people could not gather in groups of greater than 4 people in public areas from March 29 to May 4, 2020, during which this study was conducted (April 21–28, 2020). The context allows for testing the applicability of TPB to social distancing, as people in Hong Kong could exercise volitional choices of meeting up with friends and going to public places.

This study investigated the levels of three types of social/physical distancing indicators (the number of close physical contacts, avoidance of social gatherings, and physical distancing in public places), and their associated factors derived from the TPB (positive/negative attitudes, subjective norm, and perceived behavioral control related to social/physical distancing).

METHODS

Study design

A random landline telephone survey was conducted among Hong Kong Chinese adults (aged ≥18 years) during April 21–28, 2020. The inclusion criteria of participants included those who were (a) Hong Kong residents, (b) ≥18 years old, (c) capable of speaking and understanding Cantonese, and (d) willing to participate in the survey with verbal informed consent. The eligible participants were anonymously interviewed between 6 and 10:30 pm, to avoid over-sampling non-working individuals, for 10–15 min by experienced interviewers. Telephone numbers were randomly drawn from the most updated residential telephone directory. Unanswered telephone calls were given at least three attempts before being classified as invalid. Unavailable eligible participants were contacted

again by appointments. No incentives were given to the participants. Excluding those dials involving invalid non-households and empty numbers, 799 dials were able to identify eligible prospective participants in households, while 119 dials called households that did not have an eligible person. (Thus, 918 households were dialed and answered the call.) The cooperation rate, defined as the number of completed interviews ÷ the number of eligible contacts, was 54.3% (i.e., 300 ÷ 552 × 100% = 54.3%). The response rate, defined as the number of completed interviews ÷ (the number of eligible contacts + the number of cases of unknown eligibility among the valid calls)], was 37.5% [i.e., 300 ÷ (552 + 247) × 100% = 37.5%] [14]. Ethics approval was obtained from the corresponding author's affiliated institution.

Measures

Background variables

Information about socio-demographics and perceived chance of having close physical contacts during work (1 = extremely low/not applicable to 5 = extremely high) was collected.

Three social distancing measures

1. *Number of Close Physical Contacts Indicator (NCPCI)*: Participants estimated the number of people in close physical contacts (0, 1–5, 6–10, 11–20, and >20) within 1.5 m for over 3 min in the previous day in 10 types of public venues: (i) workplace (e.g., clients meetings), (ii) private social gatherings (e.g., weddings), (iii) supermarkets or shops, (iv) shopping malls but outside shops, (v) restaurants, (vi) clinics and hospitals, (vii) public transportation, (viii) large public events (e.g., exhibitions), (ix) churches, and (x) entertainment venues (e.g., bars). A score summed up all 10-item numbers using the categories' midpoints (i.e., 0, 3, 8, 15.5); the maximum number within each category capped at 21 for those who reported >20 people.
2. *Avoidance of Social Gatherings Scale (ASGS):* The two-item scale assessed how frequently participants (i) avoided social gatherings, and (ii) reduced frequency of meetings with acquaintances in the past week (1 = never to 5 = always; Cronbach's alpha = 0.91).
3. *Physical Distancing in Public Venues Scale (PDPVS):* The five items assessed participants' levels of physical distancing in public venues (past week), including avoidance of (i) going out unless necessary, (ii) visiting crowded places, (iii) staying <1.5 m with other people, (iv) gatherings of >4 persons, and (v) using public transportation (1 = never to 5 = always; Cronbach's alpha = 0.74)

TPB constructs

Since there are no available scales for measuring the TPB constructs in the context of social distancing, such measures were constructed for this study, following the guideline recommended by the developer of the TPB [15]. Namely, (a) defining the behavior clearly in terms of its target, action, context, and time elements, and (b) formulation of items following the conceptualization of the TPB constructs and making references to their examples, as well as previous studies (e.g., [16–18]) and the context of the pandemic [7, 19–22].

1. *Positive Attitudes toward Social Distancing Scale (PAS):* Participants were asked how much they agreed with the two statements: "Reducing the number of people gathering in public places and imposing physical distancing >1.5 m in public areas are effective in containing the COVID-19 epidemic (or reduce the number of newly confirmed COVID-19 cases)" (1 = extremely disagree to 5 = extremely agree). The summative scale showed a Cronbach alpha of 0.87.
2. *Negative attitudes toward social distancing:* Participants were asked how much they agreed with the two statements: "Reducing the number of people gathering in public places and imposing physical distancing >1.5 meters in public areas would bring me big inconvenience (or is unnecessary)" (1 = extremely disagree to 5 = extremely agree). Since Cronbach's alpha was low (0.21), the two single items were used separately for data analysis.
3. *Subjective norm toward social distancing:* A single item was used: "My family members and friends would support me to avoid making close physical contracts with other people in public areas" (1 = extremely disagree to 5 = extremely agree).
4. *Perceived Behavioral Control for Social Distancing Scale (PBCS):* The seven items asked "If you wanted to, how much could you control whether to avoid i) going out unless necessary, ii) joining social gatherings, iii) reducing meetings with acquaintances, iv) visiting crowded places, v) keeping a physical distance of >1.5 meters from other people, vi) gatherings of >4 persons in public venues, and vii) using public transportation" (1 = extremely low to 10 = extremely high; Cronbach's alpha = 0.84).

Statistical analysis

The Software Pass 11.0 was used for sample size planning. According to a meta-analysis, the estimated slopes of TPB constructs on health-related behaviors (e.g., physical activity, safe sex, and binge drinking) obtained by linear regression analysis were larger than the suggested slopes (attitude-behavior: 0.20–0.30; subjective norm-behavior: 0.18–0.26; perceived behavioral control-behavior: 0.22–0.31) [23]. A sample size of 300 would be able to detect slopes of 0.16 and larger in linear regression analysis, given power = 0.80, significant level [two-tailed] = 0.05) and using standardized independent and dependent variables (i.e., standardized deviations = 1). Hence, the planned sample size of 300 participants was considered adequate and being

used to test the associations between TPB constructs and social distancing behaviors in this study.

Pearson correlations, univariate linear regression, and multivariate linear regression analyses (adjusted for all the studied background variables, i.e., sex, age groups, marital status, educational level, and perceived chance of close physical contacts during work) were conducted to test the associations between background factors/TPB constructs and the three social distancing scales (i.e., NCPCI, ASGS, and PDPVS). Data analysis was conducted by SPSS21.0. Statistically and marginally significant levels were defined as two-tailed $p < .05$ and $.05 < p < .10$, respectively.

RESULTS

Descriptive statistic

Characteristics of participants

Of 300 participants, about half were aged >56 years (47.4%), females (67.3%), and married/cohabitating with their partners (65.3%). About one-quarter had tertiary education (25.6%) and self-perceived moderate/high probability in having close physical contacts during work (26.7%) (Table 1).

Levels of social/physical distancing

In the day prior to the survey, participants had on average 15.3 close physical contacts (SD/range of NCPCI: 19.6/0–87). The breakdowns in descending order were: *transportation [mean = 5.0 (SD = 7.5; range = 0–21)], supermarkets/shops [mean = 3.6 (SD = 6.3; range = 0–21)], shopping malls but outside shops [mean = 3.1 (SD = 6.6; range = 0–21)], restaurants [mean = 1.9 (SD = 4.0; range = 0–15.5)], workplaces [mean = 1.4 (SD = 4.2; range = 0–21)], private social gatherings [mean = 0.2 (SD = 1.0; range = 0–8)], and clinics/hospitals [mean = 0.1 (SD = 1.2; range = 0–15.5)].* Such data is not presented in the tables. As large public events/churches/entertainment venues were shut down during the survey period, no contacts were reported under those three scenarios.

Table 1 | Background Characteristics of the Participants ($n = 300$)

	n	%
Sex		
Male	98	32.7
Female	202	67.3
Age		
18–35	53	17.7
36–55	102	34.0
56–65	65	21.7
>65	77	25.7
Missing data	3	1.0
Marital status		
Single/separated/divorced/widow/widower	104	34.7
Cohabitation/married	196	65.3
Educational level		
≤primary school	53	17.7
Middle school/matriculation	169	56.3
≥College	77	25.6
Missing data	1	0.3
Perceived chance of close physical contacts with others (<1.5 m) during work		
Not applicable/extremely low/low	220	73.3
Moderate/high/extremely high	80	26.7

As presented in Table 2, the majority frequently/always avoided social gatherings (78.7%) and reduced social contacts (78.3%) in the past week. The majority frequently/always practiced physical distancing in public venues and avoided (i) going out unless necessary (78.0%), (ii) visiting crowded places (83.0%), (iii) close physical contacts of <1.5 m (67.4%), and (iv) gatherings of >4 people (78.0%). Fewer people avoided using public transportation (40.4%). The mean (SD/range) scores of the ASGS and PDPVS were 8.3 (2.4/2–10) and 19.5 (4.1/5–25), respectively.

Levels of TPB-related factors

As shown in Table 2, the majority agreed/extremely agreed with the two statements representing positive attitudes toward social distancing (76.0% and 74.0%, respectively). About 1/3 and 1/5 of the participants agreed/extremely agreed that social distancing was very inconvenient and unnecessary (34.0% and 20.3%, respectively). Agreements with subjective norm were 87.7%. Regarding the PBCS items, the mean (SD; range) values were*: (i) overall perceived behavioral control: 58.1 (9.9; 18–70), (ii) control over not going out unless necessary: 8.6 (1.9; 1–10), (iii) control over avoiding social gatherings: 9.0 (1.6; 1–10), (iv) control over reducing meetings with acquaintances: 8.9 (1.7; 1–10), (v) control over visiting crowded places: 8.7 (1.6; 1–10), (vi) control over keeping a physical distance of >1.5 m: 7.8 (2.1; 1–10), (vii) control over gatherings of >4 persons: 8.6 (1.7; 1–10), and (viii) control over avoiding public transportation: 6.5 (6.5; 3.0).* Such descriptive statistics of the PBCS were not tabulated.

Associations between background variables and the three social/physical distancing scales

The results are shown in Table 3. With one exception, higher age was associated with the three social/physical distancing scales. The positive association between marital/cohabitation status and NCPCI/ASGS was of marginal/statistical significance. The necessity to encounter close physical contacts during work was positively associated with NCPCI and negatively associated with PDPVS, respectively. In general, sex and educational level were not significantly associated with the social distancing measures, except for a positive association between educational level and NCPCI.

Table 2 | Descriptive Statistics of the Social/Physical Distancing Measures and Constructs of the Theory of Planned Behaviors (n = 300)

	Never/ extremely disagree (%)	Rarely/ disagree (%)	Sometimes/ neutral (%)	Frequently/ agree (%)	Always/ extremely agree (%)
Social distancing measures					
(1) Avoidance of Social Gatherings Scale (ASGS)					
Avoided social gatherings	9.3	3.7	8.3	18.7	60.0
Reduced frequency of meeting with acquaintances	8.0	3.0	10.7	26.0	52.3
(2) Physical Distancing in Public Venues Scale (PDPVS)					
Avoided going out unless necessary	5.3	5.7	11.0	25.3	52.7
Avoided visiting crowded places	3.0	4.3	9.7	29.7	53.3
Avoided staying <1.5 m with others	3.7	7.0	22.0	30.7	36.7
Avoid gatherings of >4 people	6.0	3.0	13.0	27.0	51.0
Avoid taking public transportation	17.7	17.7	24.3	18.7	21.7
Factors of theory of planned behaviors					
(1) Attitude					
Positive attitude toward Social Distancing in Public Places Scale (PAS)					
Effective	2.7	4.7	16.7	39.7	36.3
Reducing the number of COVID-19 cases	3.7	11.3	11.0	41.0	33.0
Negative attitude toward social distancing in public places					
Inconvenient	17.0	30.7	18.3	26.7	7.3
Unnecessary	28.0	41.3	10.3	14.0	6.3
(2) Subjective norm toward social/physical distancing	0.3	1.7	10.3	50.7	37.0

Table 3 | Simple Linear Logistic Regression Analyses Between Background Variables and Social/Physical Distancing Measures (n = 300)

	Social/physical distancing measures					
	Number of Close Physical Contacts Indicator (NCPCI)		Avoidance of Social Gatherings Scale (ASGS)		Physical Distancing in Public Venues Scale (PDPVS)	
	Beta	*p*	*Beta*	*p*	*Beta*	*p*
Sex						
Male	Ref		Ref		Ref	
Female	0.03	.607	0.05	.398	0.08	.196
Age						
18–35	Ref		Ref		Ref	
36–55	−0.03	.687	0.09	.260	0.11	.155
56–65	−0.18	.012	0.27	<.001	0.33	<.001
>65	−0.31	<.001	0.08	.302	0.25	.001
Marital status						
Single/separated/divorced/widow/widower	Ref		Ref		Ref	
Cohabitation/married	−0.10	.100	0.13	.028	0.09	.129
Educational level						
≤Primary school	Ref		Ref		Ref	
Middle school/matriculation	0.25	.001	−0.13	.110	−0.07	.397
≥College	0.11	.140	−0.10	.194	−0.05	.559
Perceived chance of close physical contacts during work						
Not applicable/extremely low/low	Ref		Ref		Ref	
Moderate/high/extremely high	0.14	.013	−0.02	.769	−0.11	.053

Associations between TPB-related factors and the three social/physical distancing measures

The simple correlation coefficients are presented in Table 4. Adjusted for all background variables (Table 5): (a) the PAS (beta ranged from −0.21 to 0.15) and the PBCS (beta ranged from −0.31 to 0.60) were significantly associated with all three social/physical distancing scales. (b) The two negative items (inconvenience and lack of necessity) were not significantly associated with any of the three scales. (c). Subjective norm was positively associated with NCPCI (beta = −0.14, p = .014) but not ASGS and PDPVS.

DISCUSSION

On average, Hong Kong people made considerable close physical contact with 15.3 people in a single day, which was not a small number given that the city was prohibiting gatherings of >4 persons. In a densely populated city like Hong Kong, it may be very difficult to avoid making close physical contact with people in public areas. The same may be true for other megacities (e.g., New York and Tokyo). The collection of NCPCI data has some potential applications. First, it is warranted to examine NCPCI figures across countries to understand more about the global situations and trends of social distancing. Second, within-country tracking of changes in NCPCI figures over time is important as COVID-19 and social distancing may prevail over a long period of time. Changes in NCPCI over time may reflect the degree of compliance to changes in governmental social distancing policies; surges in NCPCI due to loosening of social distancing measures or "prevention fatigue" would send the government a warning signal for possible resurges in incidents of COVID-19 cases. Third, testing the significance of the correlation between NCPCI and the cumulative/new numbers of COVID-19 cases across countries would provide empirical evidence to the effectiveness of social distancing policies in controlling COVID-19. Fourth, NCPCI may interact with various personal preventive behaviors to determine the number of COVID-19 cases; the joint trends of NCPCI and personal preventive behaviors can be used to model the surge and wane of the COVID-19 pandemic over time. Changes in NCPCI may also be implicative of economic changes. The measurement created in this study is only a starting point; it needs to be refined and validated across countries before application to the real world.

Those who were young, single, and had had attained secondary education were less likely to have practiced ≥1 type of social distancing. It is plausible that these groups tended to have more active lifestyle. Health promotion programs should target these socio-demographic groups; the contents should be as tailored as possible.

It is seen that over 75% of close physical contacts were made in public transportation, shops, and shopping malls, while the mean numbers of close physical contacts made in restaurants, workplaces, social gatherings, and clinics were quite low (1–2 on average). It is plausible that basic activities such as traveling and shopping could not be avoided, although people tried to reduce unnecessary activities. As hand hygiene is important, disinfectant dispensers should be installed in shops and subway stations.

Compared to many countries, the social distancing policy in Hong Kong was relatively loose, as it only prohibited gatherings >4 people and closed entertainment venues. Notably, despite the relatively high number of close physical contacts, the number of reported COVID-19 cases in Hong Kong remained relatively low. It is plausible that the combined effects of the high prevalence of face mask use and

Table 4 | Correlations Between Constructs of Theory of Planned Behavior and Social/Physical Distancing Measures (n = 300)

	Social/physical distancing measures					
	Number of Close Physical Contacts Indicator (NCPCI)		Avoidance of Social Gatherings Scale (ASGS)		Physical Distancing in Public Venues Scale (PDPVS)	
	r	*p*	*r*	*p*	*r*	*p*
Attitude						
Positive attitude toward Social Distancing in Public Places Scale (PAS)	−0.27	<.001	0.15	.011	0.21	<.001
Negative attitude toward social distancing in public places						
Very inconvenient	−0.02	.728	0.11	.051	0.01	.962
Unnecessary	0.04	.543	−0.04	.498	−0.09	.134
Subjective norm toward social distancing in public places	−0.19	.001	−0.05	.371	0.08	.193
Perceived Behavioral Control for Social Distancing Scale (PBCS)	−0.34	<.001	0.24	<.001	0.63	<.001

Table 5 | Adjusted Linear Regression Analyses on the Associations Between Constructs of Theory of Planned Behavior and Social/Physical Distancing Measures ($n = 300$)

	Social/physical distancing measures								
	Number of Close Physical Contacts Indicator (NCPCI)			Avoidance of Social Gatherings Scale (ASGS)			Physical Distancing in Public Venues Scale (PDPVS)		
	Beta	*p*	*R-squared*	*Beta*	*p*	*R-squared*	*Beta*	*p*	*R-squared*
Attitude									
Positive attitude toward Social Distancing in Public Places Scale (PAS)	−0.21	.001	0.149	0.14	.030	0.088	0.15	.017	0.117
Negative attitude toward social distancing in public places									
Inconvenient	−0.05	.412	0.118	0.08	.155	0.080	−0.01	.953	0.099
Unnecessary	−0.01	.833	0.116	−0.03	.677	0.074	−0.04	.497	0.101
Subjective norm toward social distancing in public places	−0.14	.014	0.134	−0.09	.130	0.081	0.02	.683	0.100
Perceived Behavioral Control for Social Distancing Scale (PBCS)	−0.31	<.001	0.196	0.21	.001	0.109	0.60	<.001	0.413

Note: The multivariate linear regression models were adjusted for sex, age (dummy variables), marital status, educational level (dummy variables), and perceived chance of close physical contacts during work.

hand washing of >95% [13, 24] and the meticulous testing/tracking/quarantines might have offset the transmission risk due to the considerable number of close physical contacts in Hong Kong. Previous studies have suggested that such measures were effective in reducing transmissions of SARS [25] and COVID-19 [13, 26]. It is interesting to discuss whether there is a balance between social distancing and relatively normal life, given co-existence of other strong prevention policies and behaviors. Empirical proof is, however, very difficult although modeling may give some insights.

The local compliance rate of banning gatherings in groups of >4 persons in public areas was as high as 80%. The imperfect low compliance rate might be partially due to the need for public transportation in Hong Kong. The majority of the Hong Kong general public had practiced some types of social distancing measures (e.g., avoided going out) that had not been banned, possibly voluntarily. The good performance of social distancing, in general, was associated with the general public's high levels of positive perceptions based on the TPB, including positive attitudes, subjective norms, and behavioral control related to social distancing. To improve social distancing in different countries, the government may attempt changing the public's perceptions in these regards. It is interesting that negative attitudes (e.g., perceived inconvenience) were not significantly associated with any of the three social/physical distancing scales; the benefits might have overridden the inconvenience resulted from social distancing. In general, the findings have suggested that the TPB can be applied to explain social distancing behavior. TPB involves factors of individual levels (attitude and perceived behavioral control) and interpersonal levels (subjective norms), which has been commonly used in explaining protective behaviors related to emerging infectious diseases including COVID-19 [10, 27, 28]. It is, however, important to consider factors of community level. According to the socio-ecological model, individual, interpersonal, and structural factors are all important in determining health-related behaviors [29]. Examples of community-level factors to be investigated in future studies include policies, laws, closure of venues, social norms, collectivism, and the number of infections related to COVID-19.

This study has some limitations. First, the cross-sectional design cannot make causal inferences. Second, the measurements of social/physical distancing and TPB were constructed for this study, as similar scales were unavailable. Third, the NCPCI may be subjected to recall bias, which may be minimized by restricting the recall period to the single day prior to the survey. However, that day might not be a typical one. Fourth, the response rate was 54.3%. Although it was comparable to other telephone surveys in Hong Kong [30, 31], the participants might differ from the non-participants. Fifth, some socially desirable responses may introduce

reporting bias. Last, the present study did not investigate personal and family history of COVID-19 infections, as the number of COVID-19 infection was only around 1,000 (including many non-residents) in the population of 7.45 million. The chance of recruiting infected person and their families is extremely low and whether or not to exclude those very few cases, if any, would not make a practical difference to the study's conclusions. Future studies may ask about infections among significant others.

CONCLUSIONS

Social distancing is of growingly global importance. The scales developed in this study have potential implications for evaluations, modeling, and cross-cultural comparisons. A majority of participants avoided social gatherings and adopted physical distancing in public areas. However, the number of close physical contacts remained relatively high. Determinants derived from TPB, in general, were associated with the three social/physical distancing indicators. Such findings may inform related health promotion to improve social distancing. Besides, cross-cultural and time-series studies are warranted. The new indicators of social distancing can potentially be modified and adapted to other countries' contexts.

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Compliance With Ethical Standards

Conflict of Interest: The authors declared no conflicts of interest.

Human Right: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by the Survey and Behavioral Research Ethics Committee of the Chinese University of Hong Kong (No. SBRE-19–660).

Informed Consent: Informed consent was obtained from all individual participants included in the study. This article does not contain any studies with animals performed by any of the authors.

Author contribution: Y.Y. and J.T.F.L. conceptualized the study; J.T.F.L. designed the questionnaire; M.M.C.L. collected data; Y.Y. performed data analysis; Y.Y. and J.T.F.L. wrote and revised the manuscript.

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