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Multi-dimensional factors related to participation in a population-wide mass COVID-19 testing program among Hong Kong adults: A population-based randomized survey

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ABSTRACT

Rationale: Mass testing is considered as an important policy response to the COVID-19 pandemic, and high population coverage is pivotal to its effectiveness. A range of factors derived from health behaviour theories were hypothesized to be associated with public uptake of mass testing, including illness representations of COVID-19, perceived susceptibility to COVID-19, perceived efficacy of the testing program, and general trust toward governmental measures for controlling COVID-19.

Objective: This study aimed to investigate the multi-dimensional factors associated with participation in a free and voluntary population-wide mass COVID-19 testing program.

Methods: A cross-sectional study was conducted in Hong Kong within two weeks after the Universal Community Testing Program for COVID-19 concluded on September 14, 2020. A random population-based telephone survey interviewed 443 Hong Kong general adults who were aged ≥ 18 and had not joined other COVID-19 testing programs. The dependent variable was participation in the Universal Community Testing Program. Logistic regression analysis was conducted to test the associations of participation in the program with the proposed factors.

Results: The standardized participation rate of the testing program was estimated to be about 37.2% among the general adults (33.0% among males; 40.8% among females) in Hong Kong. The participation rates were significantly lower among males and younger adults. Adjusted for socio-demographics, significant factors included four dimensions of illness representations of COVID-19 (treatment control: adjusted odds ratio [AOR] = 1.41; illness identity: AOR = 1.10; concern: AOR = 1.14; emotions: AOR = 1.10), perceived susceptibility to COVID-19 (AOR = 1.40), perceived efficacy of the testing program (AOR = 2.73), and trust toward governmental control measures (AOR = 4.30).

Conclusions: The participation rate of the population-wide mass testing program was not high among general adults in Hong Kong, evidence-based health promotion is necessary. The study informs some critical factors to be addressed to effectively boost public support for the mass testing policy in response to emerging infectious diseases.

1. Introduction

As of November 16, 2021, there were over 252 million accumulated coronavirus disease (COVID-19) cases and 5 million deaths worldwide; resurgences continue to occur in some regions and the incidence rate remains high (WHO, 2021). COVID-19 is highly infectious and involves a considerable proportion of asymptomatic/pre-symptomatic infections (Nikolai et al., 2020; Wu et al., 2020). A recent meta-analysis found that

31% of the COVID-19 cases detected via screening were entirely asymptomatic (Buitrago-Garcia et al., 2020). Also, many COVID-19 cases do not present severe symptoms and/or early onset of fever (Wu et al., 2020) and may thus require less frequent clinical care seeking (Chu et al., 2020). The invisible transmission chains silently perpetuate and escalate the spread of COVID-19 within communities.

Unfortunately, the existing public health measures (e.g., screening symptomatic people and contact tracing, massive lockdowns, social

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distancing) seem unable to control the pandemic and may become less sustainable as motivation for compliance declines (Michie et al., 2020) and socioeconomic losses emerge (Keogh-Brown et al., 2020). Mass testing is considered a new means to tackle the COVID-19 crisis (Studdert and Hall, 2020). It can identify asymptomatic/pre-symptomatic carriers, curb community transmissions and thus reduce the burden on the healthcare system (ECDC, 2020), enhance surveillance of disease evolution (Peeling et al., 2020), augment the efficiency of contact tracing (E. Clark, Chiao and Amirian, 2020), liberate workforce from unnecessary quarantines, and facilitate restoration of the economy (Atkeson et al., 2020).

In response to the rapid spread of COVID-19, countries such as China (Pan et al., 2020), Luxembourg (Luxembourg Institute of Health, 2020), Slovakia (Holt, 2020), and the U.K. (Iacobucci, 2020) have successfully rolled out free population-wide mass testing programs in some of their cities or throughout the country, while some countries (e.g., Germany and Korea) have implemented mass testing programs in highly affected communities (Dighe et al., 2020; ECDC, 2020), which has also been recommended by the U.S.'s CDC (Centers for Disease Control and Prevention, 2020). In Hong Kong, the government implemented the 'Universal Community Testing Program (UCTP)' during 1–14 September 2020 after a third-wave outbreak, which offered one-off, free, and voluntary COVID-19 testing services to all the local residents aged ≥ 6 years. Finally, 1.78 million people participated in the program; 45 confirmed COVID-19 cases were detected, of whom 41% showed no symptoms (see online Appendix 1).

Effective population-wide mass COVID-19 testing requires a high population coverage and a good understanding of the factors of public participation. To our knowledge, no related study has been reported. The present study employed some classic health behaviour theories to investigate factors of participation in the UCTP. The self-regulation theory of the Common-Sense Model (CSM) postulates that how people think and feel about a disease [i.e., the multidimensional cognitive/emotional illness representations (IR)] influences one's coping responses and subsequent adaptive behaviours regarding disease prevention and management (Leventhal et al., 2003). Accordingly, an individual might take up COVID-19 testing if his/her IR of COVID-19 align with perceptions on negative life impacts (*consequences*), severe symptoms (*identity*), long duration (*timeline*), controllability through personal actions (*personal control*) or treatments (*treatment control*), comprehensibility (*coherence*), and fear and concern (*emotional representation*) (Hagger et al., 2017). Such contentions have been supported by empirical studies that reported significant associations between treatment control/emotional representations regarding H1N1 and preventive behaviours (e.g., mask-wearing and hand hygiene) (Karademas et al., 2013; Mo and Lau, 2015).

Two constructs of the Health Belief Model (HBM), perceived susceptibility to COVID-19 and perceived benefit (i.e., perceived efficacy of the mass testing program) (Rosenstock, 1974), were used to supplement the CSM model because these variables are important determinants of health behaviours (Ferrer and Klein, 2015; Milne et al., 2000). However, mixed findings were reported for their associations with preventive behaviours related to COVID-19 (C. Clark, Davila, Regis and Kraus, 2020; Lee and You, 2020; Ozdemir et al., 2020; Vandrevalla et al., 2020). As the Socio-Ecological Model posits that contextual factors play critical roles in shaping health-related behaviours (Bronfenbrenner, 1979), general trust toward governmental control measures was included as a potential contextual factor of participation in the UCTP. Extant literature reported mixed findings in the associations between trust toward governmental responses to COVID-19 and adoption of preventive measures (C. Clark et al., 2020; Ozdemir et al., 2020; Vandrevalla et al., 2020).

The present study investigated the associated factors of participation in the UCTP, including a) cognitive and emotional IR of COVID-19, b) HBM-derived factors (i.e., perceived susceptibility to COVID-19 and perceived efficacy of the testing program), and c) general trust toward

governmental COVID-19 control measures.

2. Methods

2.1. Study procedures

A random anonymous population-based telephone survey was conducted during September 16–30, 2020 (i.e., within two weeks after the completion of the UCTP). Inclusion criteria were 1) Hong Kong residents, 2) Chinese speaking, 3) aged ≥ 18 years. Residential fixed-line telephone numbers were randomly drawn from the most updated phone directories. Well-trained fieldworkers called the selected households, briefed the participants about the study, obtained verbal informed consent, and administered the survey that took 15 min to complete. No incentive was given to the participants. Of the 875 eligible participants, 450 (51.4%) completed the survey. Excluding seven cases that had joined other COVID-19 testing programs, the final sample size was 443. Ethical approval was obtained from the ethics committee of the corresponding author's affiliated institution. See Appendix 2 for more information.

2.2. Measures

A structured questionnaire was used to measure participation in the UCTP and reasons for non-participation, cognitive and emotional IR of COVID-19, perceived susceptibility to COVID-19, perceived efficacy of the testing program, general trust toward governmental COVID-19 control measures, and sociodemographic variables. See Appendix 3 for more information.

2.3. Statistical analysis

Univariate logistic regression models were first fit to examine the associations between the studied factors and participation in the UCTP; crude odds ratios (ORc) were estimated. Adjusted odds ratios (AOR) were estimated for the associations between COVID-19-related perceptions variables and participation in the UCTP, adjusting for the significant socio-demographics. Finally, a multivariate regression model that simultaneously included all the significant socio-demographics and COVID-19-related perceptions was fit to examine their independent effects; multivariate odds ratios (ORm) were estimated. The respective 95% confidence intervals were also reported. A two-tailed p -value < 0.05 indicated statistical significance. SPSS 26 was used for analysis.

3. Results

3.1. Sample characteristics

Of the 443 participants, 31.2% were males; 41.5% were aged 46–65 and 32.5% were aged >65 years old; 30.2% had attended colleges or above; 70.4% were married; 33.9% were employed full-time. The mean scores of the eight dimensions of IR of COVID-19 ranged from 4.48 to 8.28; the mean scores (standard deviation) of perceived susceptibility to COVID-19, perceived efficacy of the testing program, and trust toward governmental control measures were 2.47 (0.82), 3.12 (1.19), and 3.04 (1.01), respectively. See Table 1 for more information.

3.2. Prevalence of participation in the UCTP

Around 47.0% of the sample had participated in the UCTP (males: 39.9%; females: 50.2%). The prevalences were 20.0%, 46.2%, 69.4% among those aged 18–45, 46–65, and >65 , respectively. Among the 235 non-testers, the top three reasons for non-participation were: "no risk of infection" (41.7%), "no time to participate" (26.4%), and "the program was not effective in controlling the local pandemic" (16.2%). The other reasons included "inaccurate testing results" (10.2%), "crowds at the

Table 1
Sample characteristics (n = 443).

Variables	n (%) or mean ± standard deviation
<i>Sociodemographic background</i>	
Sex	
Male	138 (31.2)
Female	305 (68.8)
Age (years old)	
18-45	115 (26.0)
46-65	184 (41.5)
>65	144 (32.5)
Education level ^a	
Junior secondary school and below	170 (38.4)
Senior secondary school	138 (31.2)
College and above	134 (30.2)
Marital status ^a	
Single	91 (20.5)
Married	312 (70.4)
Divorced/widowed	39 (8.8)
Employment status	
Full-time	150 (33.9)
Retired	137 (30.9)
Housewives	114 (25.7)
Else	42 (9.5)
<i>Participation in the Universal Community Testing Program</i>	
Yes	208 (47.0)
No	235 (53.0)
<i>Perceptions related to COVID-19</i>	
Illness representations of COVID-19	
1. Consequences	8.28 ± 1.60
2. Timeline ^a	6.98 ± 1.69
3. Personal control	5.61 ± 2.32
4. Treatment control ^a	6.96 ± 1.53
5. Illness identity	5.42 ± 3.13
6. Concern	5.25 ± 2.73
7. Coherence	6.51 ± 1.40
8. Emotions	4.48 ± 2.96
Perceived susceptibility to COVID-19	2.47 ± 0.82
Perceived efficacy of the testing program in controlling COVID-19	3.12 ± 1.19
Trust toward governmental measures for controlling COVID-19	3.04 ± 1.01

Note a. These variables had missing values (education level: n = 1; marital status: n = 1; timeline: n = 2; and treatment control: n = 1).

testing sites” (9.4%), “political concerns” (8.9%), “troublesome/painful” (2.6%), “physical barriers (e.g., disability)” (2.1%), and “logistic barriers (e.g., don’t know how to participate)” (0.9%). About 24.2% of the participants reported more than one reason.

3.3. Factors of participation in the UCTP

3.3.1. Background factors

The results showed that being female (ORc = 1.52), middle-/older-aged (ORc ranged from 3.43 to 9.09; reference group: aged 18–45), married/ever-married (ORc ranged from 4.15 to 6.77; reference group: single), and retired/housewife (ORc ranged from 2.56 to 3.27; reference group: full-time employment) were positively associated with participation in the UCTP. Higher education levels were negatively associated with participation in the UCTP (ORc ranged from 0.29 to 0.34; reference group: junior secondary school and below). When all the above sociodemographic variables were simultaneously included in a regression model, only being middle-/older-aged (ORm ranged from 2.40 to 6.18) and married (ORm = 2.06, 95% CI = 1.23 to 4.69) remained significant. Appendix 4 provides more information.

3.3.2. Perceptions related to COVID-19

Adjusted for the sociodemographic variables, the COVID-19-related perceptions that had a positive association with participation in the UCTP included: 1) four IR dimensions [treatment control, illness

identity, concern, and emotions (AOR ranged from 1.10 to 1.41)], 2) perceived susceptibility to COVID-19 (AOR = 1.40, 95% CI = 1.07 to 1.83), 3) perceived efficacy of the testing program (AOR = 2.73, 95% CI = 2.12 to 3.51), and 4) trust toward governmental control measures (AOR = 4.30, 95% CI = 3.08 to 5.99). See Table 2.

In the multivariate regression model, concern about COVID-19 (ORm = 1.22, 95% CI = 1.02 to 1.47), perceived efficacy of the testing program (ORm = 1.70, 95% CI = 1.22 to 2.38), and trust toward governmental control measures (ORm = 3.70, 95% CI = 2.49 to 5.50) were independently associated with participation in the UCTP. Variables included in this final model were significantly correlated with each other (see Appendix 5).

4. Discussion

Based on the population census, the age- and sex-standardized prevalence of participation in the UCTP was estimated to be 37.2% (males: 33.0%, females: 40.8%) among Hong Kong general adults (Appendix 6). Although the number of testers is sizable, it may be inadequate to terminate the invisible transmission in the community. Testers were more likely to be older people, who usually reported higher health service utilization (Shao et al., 2018) and uptake of preventive measures against COVID-19 (Haischer et al., 2020). Tailored promotion of population-wide mass COVID-testing should be provided to the less motivated groups. The effects of the other sociodemographic variables (e.g., education level) may be explained by their correlations with age.

The most common reason for non-participation was the risk-free perception, which might be due to the relatively low number of local cases and the almost universal mask-wearing (Wong et al., 2020). Yet, the absolute number of local COVID-19 cases/deaths was not negligible, as resurgences often occurred following the relaxation of restriction measures. A collective “social good approach” may remind the citizens that the risk should be interpreted at the societal instead of individual level. Lack of time was the second top reason; user-friendly logistics should be designed. The importance and necessity of mass testing should

Table 2
Logistic regressions on the associations between perceptions related to COVID-19 and participation in the Universal Community Testing Program (n = 443).

Variables	ORc (95% CI)	AOR (95% CI)	ORm (95% CI)
1. Illness representations of COVID-19			
Consequences	1.06 (0.94, 1.20)	1.00 (0.88, 1.15)	\
Timeline	1.22 (1.08, 1.36) ***	1.00 (0.87, 1.14)	\
Personal control	0.99 (0.91, 1.07)	1.08 (0.99, 1.19)	\
Treatment control	1.46 (1.27, 1.69) ***	1.41 (1.21, 1.65) ***	0.93 (0.74, 1.17)
Illness identity	1.16 (1.09, 1.24) ***	1.10 (1.03, 1.19) **	1.06 (0.91, 1.25)
Concern	1.18 (1.10, 1.27) ***	1.14 (1.06, 1.24) **	1.22 (1.02, 1.47) *
Coherence	0.80 (0.70, 0.92) **	1.02 (0.87, 1.21)	\
Emotions	1.09 (1.02, 1.16) **	1.10 (1.02, 1.18) **	0.97 (0.81, 1.16)
2. Perceived susceptibility to COVID-19	1.72 (1.35, 2.19) ***	1.40 (1.07, 1.83) *	0.72 (0.49, 1.06)
3. Perceived efficacy of the testing program in controlling COVID-19	2.88 (2.30, 3.60) ***	2.73 (2.12, 3.51) ***	1.70 (1.22, 2.38) **
4. Trust toward governmental measures for controlling COVID-19	5.05 (3.69, 6.91) ***	4.30 (3.08, 5.99) ***	3.70 (2.49, 5.50) ***

Note ORc: the odds ratios obtained from univariate regressions; AOR: the odds ratio obtained from regressions with adjustment for the sociodemographic variables; ORm: the odds ratio obtained from multivariate regressions. *p < 0.05, **p < 0.01, ***p < 0.001.

be explained to the public as perceived ineffectiveness was the third reason.

The CSM is potentially useful in understanding the public uptake of mass testing as four of its constructs were significantly associated with participation in the UCTP. First, the significance of treatment control corroborates previous findings on its effect on behavioural responses to H1N1 influenza (Karademas et al., 2013; Mo and Lau, 2015); it is conceivable that effective treatment reinforces the perceived benefits of screening (French et al., 2018). Second, people who attributed more severe symptoms to COVID-19 were more likely to participate in the UCTP, which is understandable as the perceived severity of a disease would motivate apparently healthy people to take up testing to cope with the potential threat (Hagger et al., 2017). Third, higher concern and negative emotions about COVID-19 were significant factors, which corroborates previous findings that emotional representations of H1N1 and avian influenza increased the uptake of related preventive behaviours (Karademas et al., 2013; Raude and Setbon, 2011).

In addition, the significant effect found for perceived susceptibility to COVID-19 supports the HBM (Rosenstock, 1974) and empirical evidence on other COVID-19 preventive behaviours (Lee and You, 2020; Ozdemir et al., 2020). Hong Kong has a low prevalence of COVID-19 but high levels of preventive behaviours; the role of perceived susceptibility needs to be ascertained in other contexts. The perceived efficacy of the program in controlling the local outbreak was another significant factor, which corroborates some recent COVID-19 studies (C. Clark et al., 2020; Lee and You, 2020; Ozdemir et al., 2020). For instance, individuals who perceived specific protective behaviours as effective were more likely to follow government recommendations and take precautionary actions (C. Clark et al., 2020). Unlike other control measures, population-wide mass testing is an innovative strategy; its effectiveness in practice is controversial even among experts (Holt, 2020); hence, the experiences of related programs should be carefully documented, analyzed, and disseminated.

The significance of general trust toward governmental control measures is reflected by its strongest association among all the considered factors. This indicates that the effect of such trust potentially goes beyond how people think about COVID-19 or mass testing itself. Extant empirical findings on the effects of trust toward governmental responses to COVID-19 on preventive behaviours were controversial (C. Clark et al., 2020; Ozdemir et al., 2020); this study further adds to the understanding of such relationships. Uptake of mass testing among “healthy” individuals could be driven by prosocial and collective motives (e.g., to help sort out asymptomatic cases in the community), and trust in government fosters social capital and encourages cooperation and altruistic behaviours (Dincer and Gillanders, 2021). Conflicts between economic downturn and control efforts, controversies frequently disseminated on social media, and recurrent waves might have eroded the trust, which urgently needs to be built as the pandemic prolongs.

4.1. Limitations

First, the cross-sectional design was unable to draw causal conclusions. Second, around 48.6% of eligible participants did not complete the surveys. Selection bias might exist as the study sample appeared to have a larger proportion of older adults and females than the population by census. Third, the high-risk immigrant population (e.g., foreign domestic helpers) was not included. Fourth, single items were used to measure some of the factors (e.g., perceived susceptibility). Fifth, the self-reported measures may incur reporting bias related to social desirability. Finally, the findings should be generalized cautiously to other countries with different contexts, as national development status can have a crucial impact on population-level uptake of COVID-19 public health measures (Lin et al., 2021).

4.2. Implications

The study may shed some insights concerning the planning and implementation of population-wide mass testing programs for responding to the ongoing COVID-19 pandemic and future emerging infectious diseases with sizable asymptomatic transmissions. First, apart from technical and logistic considerations, potential public support is pivotal to the planning of similar programs. The effectiveness of such programs largely depends on the population coverage, while we see that the coverage of a voluntary program may not reach a very high level. Cost-effectiveness modeling according to hypothetical coverage levels and pre-program acceptance research is thus warranted to facilitate relevant policymaking.

Second, health promotion is clearly needed to improve the coverage. The findings demonstrate strong demographic differences in participation and thus the need for segmentation in health promotion by age and sex. It is essential to shape people’s representations of COVID-19 in an appropriate way to stimulate adaptive coping responses, for instance, raising awareness of risk and concerns about COVID-19. The rationale of mass testing should be introduced to the public clearly and understandably; providing knowledge about previous applications in affected regions may help heighten perceived efficacy (Jiang et al., 2009). Collective and prosocial approaches may also be considered. Lastly, sustained efforts are warranted throughout the pandemic to build up and maintain overall trust in the government’s ability to handle the situation.

5. Conclusions

This study found that the participation rate of a free and voluntary population-wide mass COVID-19 testing program was not high. Evidence-based health promotion is needed, especially among younger adults. The findings suggest that improving people’s general trust toward governmental control measures, perceived efficacy of mass testing, IR, and perceived susceptibility can potentially help enhance the population coverage of future mass testing programs in response to emerging infectious diseases.

Credit author statement

Meiqi Xin: Conceptualization, Methodology, Formal analysis, Writing – original draft. Joseph Tak fai Lau: Conceptualization, Supervision, Methodology, Writing- Reviewing and Editing. Mason Lau: Project administration, Resources, Investigation.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2021.114692>.

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