

Psychobehavioral Responses and Likelihood of Receiving COVID-19 Vaccines during the Pandemic, Hong Kong

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To access temporal changes in psychobehavioral responses to the coronavirus disease (COVID-19) pandemic, we conducted a 5-round (R1–R5) longitudinal population-based online survey in Hong Kong during January–September 2020. Most respondents reported wearing masks (R1 99.0% to R5 99.8%) and performing hand hygiene (R1 95.8% to R5 97.7%). Perceived COVID-19 severity decreased significantly, from 97.4% (R1) to 77.2% (R5), but perceived self-susceptibility remained high (87.2%–92.8%). Female sex and anxiety were associated with greater adoption of social distancing. Intention to receive COVID-19 vaccines decreased significantly (R4 48.7% to R5 37.6%). Greater anxiety, confidence in vaccine, and collective responsibility and weaker complacency were associated with higher tendency to receive COVID-19 vaccines. Although its generalizability should be assumed with caution, this study helps to formulate health communication strategies and foretells the initial low uptake rate of COVID-19 vaccines, suggesting that social distancing should be maintained in the medium term.

Since the World Health Organization declared Coronavirus disease (COVID-19) a pandemic on March 11, 2020 (1), COVID-19 has infiltrated every continent in the world (2). Hong Kong, a densely populated city located on the southern coast of China with ≈7.5 million citizens and a mean daily number of 12.5 social encounters per individual (3), recorded its first laboratory-confirmed COVID-19 case in late January 2020 (4). Since then, Hong Kong has been adopting a suppress-and-lift strategy, under which

lifting and reimposing of restrictions occurred based on epidemiologic thresholds (5). As of April 9, 2021, Hong Kong had recorded 11,550 confirmed cases and 205 deaths (crude case-fatality rate 1.8%) (6), and the fourth wave of COVID-19 epidemic had just ended. After more available data on phase 3 clinical trials of candidate vaccines (7) became available and the vaccine was authorized for emergency use, the COVID-19 vaccination program in Hong Kong began in late February 2021.

Surveillance of psychobehavioral responses during the epidemic plays an essential role to convey risk communication messages to the public. Previously, we reported that the general population in Hong Kong had high levels of perceived risk and mild anxiety during the early phase of the COVID-19 epidemic; the prompt government interventions with widely adopted individual precautionary measures might be the determinants to slow down the transmission early in the outbreak (8). After that initial analysis, which was based on cross-sectional data (8), global researchers have applied similar protocols for the general public in Japan (9), Saudi Arabia (10), Italy (11) and the United Kingdom (12). However, the temporal variations of psychobehavioral responses have not been examined.

In addition to psychobehavioral responses, unique to COVID-19 is its unprecedented massive epidemic size compared with other recent outbreaks, such that vaccination becomes the exit strategy. However, despite vaccine availability, vaccine doubters may hamper the global effort against COVID-19 (13). Unraveling the reasons behind vaccine hesitancy and monitoring its trends over time will support the design of interventions to boost COVID-19 vaccine uptake.

We report a longitudinal analysis of 5 representative population-based surveys of adults in Hong Kong

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on their psychological, behavioral, and vaccine-related responses, conducted during the first 2 waves of the COVID-19 epidemic. Our main objectives were tracking major psychobehavioral responses (including risk perception, psychological distress, and adoption of precautionary measures) over time and examining the determinants of the intention to receive the COVID-19 vaccine. As a complement, other psychobehavioral responses (such as knowledge about COVID-19) were also reported. These findings should have major implications for infection control policies and targeted mental health recommendations. Hong Kong has a high-income economy but had major social unrest in the pre-pandemic period in the population (14); thus, the experience in Hong Kong may act as a reference for other similar populations to prepare for future epidemics.

Methods

Respondent Recruitment

We established a community cohort within 36 hours after the first COVID-19 confirmed case was identified in Hong Kong. District councilors shared an online survey link through channels in which they convey information to their targeted residents (8). We arranged 5 follow-up rounds (denoted as R1–R5) of online surveys of the community cohort during January–September 2020, each lasting for 3–6 weeks: R1, January 23–February 13; R2, March 6–April 14; R3, May 8–June 14; R4, July 15–August 7; and R5, August 8–September 15. Respondents were compensated with cash vouchers in Hong Kong dollars (HKD): HKD 10 for R1, HKD 20 for R2, and HKD 30 for R3–R5.

Study Instrument

The study instrument was based on a questionnaire used during the initial phase of the COVID-19 epidemic in Hong Kong (8). In each round, we administered questions soliciting key information on demographics, health conditions, travel history, risk perceptions toward COVID-19, anxiety and burnout, confidence in the local government and doctors, knowledge about COVID-19 transmission, and adoption and perceived effectiveness of preventive measures. In response to the funding commitments for COVID-19 vaccine development (15), starting with R4, we embedded vaccine-related questions along 2 dimensions: intention to receive COVID-19 vaccines when available and vaccine hesitancy.

Psychological Responses

Risk perceptions toward COVID-19 included perceived susceptibility (of oneself and one's family

members), assuming no precautionary measure, and perceived severity. Starting with R3, we asked respondents to report their perceived susceptibility based on the situation during which they completed the survey (1, very likely; 5, very unlikely). In addition, respondents rated the level of disease severity of COVID-19 and other noncommunicable diseases and infectious diseases (1, very bad; 5, not bad at all).

We measured anxiety with the Chinese–Cantonese version of the Hospital, Anxiety and Depression Scale—Anxiety (16). Respondents rated 7 statements on the basis of their feelings in the preceding 7 days on a 4-point scale; a higher score indicated stronger anxiety (summative score: 0–7, normal; 8–10, borderline abnormal; 11–21, abnormal).

We measured burnout with a single-item measure: “Overall, based on your definition of burnout, how would you rate your level of burnout when facing COVID-19?” (1, “I have no symptoms of burnout”; 5, “I feel completely burned out and often wonder if I can go on facing COVID-19; I am at the point where I may need some changes or may need to seek some sort of help”). This single-item measure was refined from a nonproprietary validated burnout measure (17) to fit the current context and was asked starting with R3.

Behavioral Responses

Respondents rated the adoption (yes/no) (Appendix Table 1, <https://wwwnc.cdc.gov/EID/article/27/7/21-0054-App1.pdf>) and perceived effectiveness (1, very effective; 5, not very effective) (Appendix Table 2) of 17 precautionary measures against COVID-19. For the likelihood of COVID-19 vaccine uptake, respondents answered this question “If COVID-19 vaccines are available, how likely will you receive them?” (0, definitely not; 10, definitely). We measured vaccine hesitancy with a validated 15-item tool (18) with 3 items on each of 5 psychological antecedents (the 5Cs): confidence, defined as trust in the safety and effectiveness of the vaccine, the system that delivers the vaccine, and the motivations of policymakers who decide on the need of the vaccine; complacency, defined as not perceiving the disease as high risk and vaccination as necessary; constraints, defined as barriers to vaccination; calculation, defined as persons' engagement in extensive information searching; and collective responsibility, defined as willingness to protect others through herd immunity. We used an average score for each antecedent. For collective responsibility, one reverse item, “When everyone is vaccinated, I don't have to get vaccinated, too,” was excluded from the calculation.

The vaccine-related items did not include any specific information about pharmaceutical companies or manufacturing countries.

Statistical Analysis

We summarized responses using descriptive statistics. To examine the overall linear trends in the responses and to account for the correlation diminishment resulting from responses from the same respondents across time, we adopted the generalized estimation equation framework featuring an autoregressive structure for within-subject correlations. To compare the proportion of responses in 2 time points, we used a partially overlapping samples *z*-test (19).

We adopted a multivariate regression model under the generalized estimation equation framework to identify the associated factors for higher tendency for social distancing (i.e., ≥ 5 social distancing measures) and higher uptake tendency for COVID-19 vaccines (i.e., ≥ 7 of 10 for the “likelihood of receiving COVID-19 vaccines” question). We reported adjusted odds ratios (aORs) and 95% CIs and specified a statistical significance of $p \leq 0.05$. We conducted the analysis in R software version 4.0.3 (<https://www.r-project.org>). This study was approved by the Survey Behavioral Research Ethics Committee of The Chinese University of Hong Kong (reference no. SBRE-20-037).

Results

Study Timeline

The 5 study rounds intertwined epidemic waves 1 and 2 in Hong Kong (20) at different disease stages (Figure 1): the initial phase (R1), amid epidemic waves (R2 and R4), during the relative quiescence between 2 waves (R3), and the decaying phase of wave 2 (R5). The government-initiated interventions (such as school closure and compulsory mask-wearing) and the call for COVID-19 vaccine were also presented (Figure 1). The data collection was completed before any announcement of the safety and efficacy trials of the candidate vaccines. We received 2,478 attempts to complete the survey in R1, of which 1,715 provided complete responses (8) and 1,054 indicated willingness to participate in future studies. The sample sizes for R2–R5 ranged from 441 to 644 (Figure 2).

Respondent Characteristics

The cohort consisted of more female persons (68.5%–69.8%) and young adults (18–44 years of age) (78.6%–81.0%) than other categories. Most were well educated:

78.9%–82.5% had at least postsecondary level education (Appendix Table 3). Most respondents were free from chronic diseases (87.1%–88.8%) and perceived themselves to be in good health (73.1%–78.1%) (Appendix Table 4).

Risk Perception over Time

We identified significant temporal variation of risk perception toward COVID-19 (Appendix Table 5). Assuming no precaution measures, respondents perceived themselves likely to be infected with COVID-19 (87.2%–92.8%). This proportion dropped to 19.3%–42.0% when the current situations were considered, when institutionalized interventions were in place and personal protective measures were conducted en masse (Appendix Table 1).

Perceived severity decreased significantly ($p < 0.001$) over the study period, from 97.4% (R1) of respondents considering COVID-19 to be serious to 77.2% (R5). The perceived chance of having COVID-19 cured increased significantly ($p < 0.001$) by more than 3-fold, from 16.6% (R1) to 57.2% (R5). An increasing time trend ($p < 0.001$) was also observed for perceived survival chance if infected, from 18.6% (R1) to 67.2% (R5).

Psychological Distress

The mean Hospital, Anxiety and Depression Scale—Anxiety score remained borderline abnormal throughout the study, ranging from 8.99 (R1) to 7.61 (R5). There was a substantial increase in the proportion of normal respondents in terms of anxiety ($p < 0.001$), from 35.6% (R1) to 51.7% (R5) (Appendix Table 6). This anxiety metric echoed the significant drop in the frequency of thinking about COVID-19 ($p < 0.001$), from 76.2% (R1) to 48.6% (R5). Despite this ease in anxiety level, the proportion of respondents worrying specifically about COVID-19 (85.7%–96.8%) and having their daily lives affected a lot by COVID-19 (45.7%–61.8%) remained high throughout the study (Appendix Table 6). Meanwhile, $\approx 40\%$ of the respondents have shown symptoms of burnout toward COVID-19 since R3.

Adoption of Precautionary Measures

The adoption of individual precautionary measures remained high throughout the study (Appendix Table 1). Most respondents reported they wore masks (R1, 99.0%; R5, 99.8%), covered mouth and nose when coughing or sneezing (R1, 96.9%; R5, 98.4%), performed hand hygiene using hand sanitizer or alcohol gel (R1, 95.8%; R5, 97.7%), and disinfected their homes (R1, 78.6%; R5, 88.5%). Hand hygiene and

home disinfection measures showed a significant increasing trend across time.

The adoptions of social distancing across rounds were consistently from moderate to high (Appendix Table 1). About one third of respondents avoided public transportation (R1, 38.0% to R5, 35.6%; $p = 0.11$) and work (R1, 24.6% to R5, 35.4%; $p < 0.001$) across waves. Upward significant trends were

observed among respondents in avoiding social activities (R1, 63.8% to R5, 85.7%; $p < 0.001$) and contacting with persons with fever or symptoms of respiratory diseases (R1, 92.9% to R5, 95.1%; $p < 0.05$).

Factors associated with greater adoption of social-distancing were being female (aOR 1.30, 95% CI 1.09–1.56); living in the New Territories, a suburb of Hong Kong (aOR for the 2 territories 1.40–1.42); and

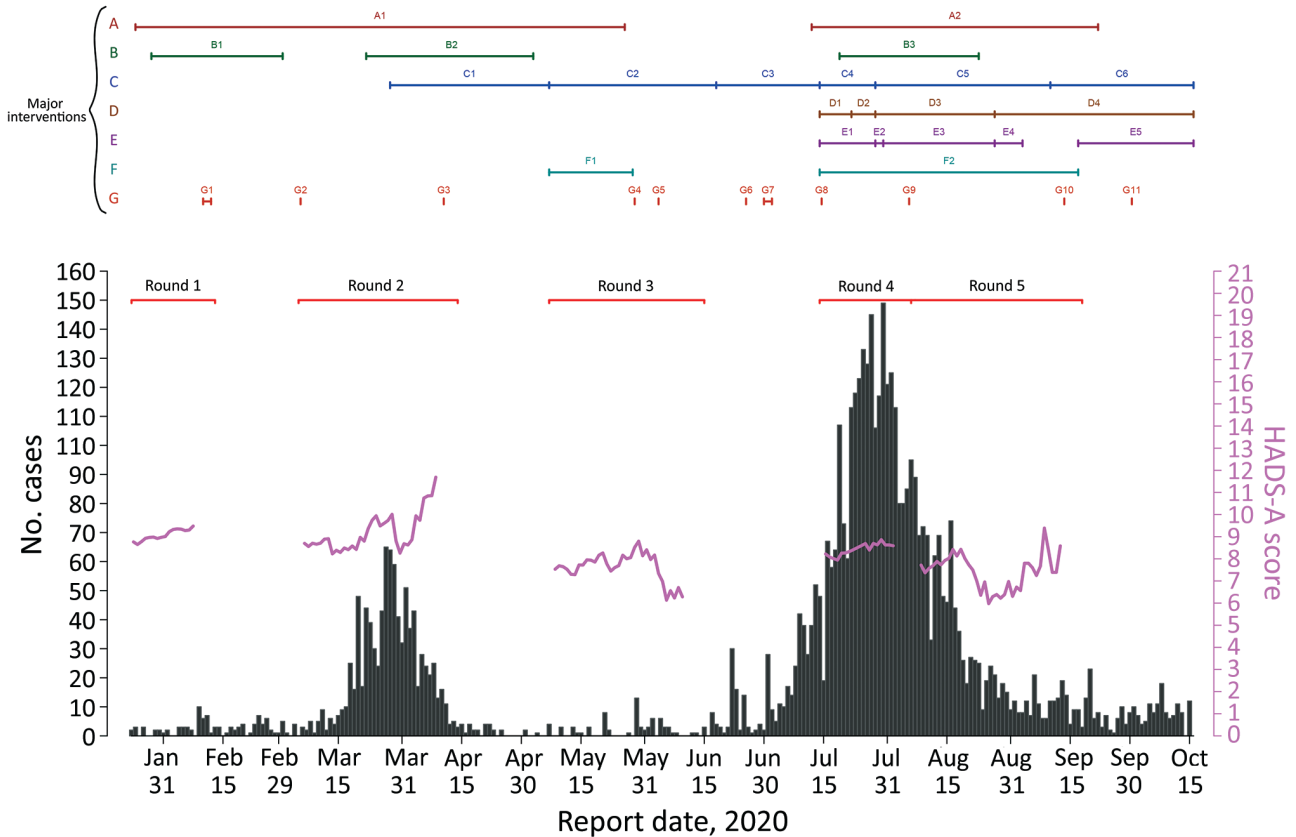


Figure 1. Coronavirus disease (COVID-19) incidence and anxiety level by report date from survey of psychobehavioral responses to the COVID-19 pandemic, showing timeline of major interventions, Hong Kong, 2020. A, school closures: A1, closure, Jan 25–May 26; A2, early start of summer holiday, Jul 13–Sep 22. B, government work-from-home arrangement: B1, Jan 29–Mar 1; B2, Mar 23–May 3; B3, Jul 20–Aug 23. C, group size limits on gatherings in public places: C1, limit 4, Mar 29–May 7; C2, limit 8s, May 8–Jun 18; C3, limit 50, Jun 19–Jul 14; C4, limit 4, Jul 15–Jul 28; C5, limit 2, Jul 29–Sep 10; C6, limit 4 persons, Sep 11–present (as of 2020 October 5). D, compulsory mask wearing: D1, on public transportation, Jul 15–present; D2, also in public indoor areas, Jul 23–present; D3, also in public outdoor areas, Jul 29–present (exemption for country parks or when engaging in strenuous physical activities in public outdoor spaces, Aug 28–present). E, regulations applied to restaurants, Mar 28–present: $\leq 50\%$ of premises capacity; tables ≥ 1.5 m apart; no more than 2, 4, or 8 persons per table; compulsory mask wearing except when consuming food or drink; compulsory body temperature screening before entry; hand sanitizer on premises; suspension of dine-in service for the following periods: E1, 6 pm–4:59 am, Jul 15–Jul 28; E2, at all times, Jul 29–30; E3, 6 pm–4:59 am, Jul 31–Aug 27; E4, 9 pm–4:59 am, Aug 28–Sep 3; E5, 12 am–4:59 am, Sep 18–present. F, business closures: F1, bathhouses, party rooms, clubs, karaoke clubs, May 8–May 28; F2, bathhouses, party rooms, clubs, karaoke clubs (all reopened Sep 17), swimming pools (beginning Jul 29), sports premises (Jul 29–Aug 28), clubhouses (reopened Aug 28), beauty parlors (reopened Aug 28), massage establishments (reopened Sep 4), places of public entertainment (reopened Aug 28), places for amusement (reopened Sep 4), fitness centers (reopened Sep 4), and amusement game and mahjong-tin kau establishments (reopened Sep 11). G, vaccine development timeline: G1, World Health Organization (WHO) Convention of Global Research and Innovation, Feb 11–12; G2, WHO Global Research Roadmap prioritizing vaccine development, Jun 3; G3, draft landscape of candidate vaccines, Apr 11; G4, launch of COVID-19 Access Pool for sharing data for vaccine development, May 29; G5, funding commitment at Global Vaccine Summit for immunization in low-income countries, Jun 4; G6, call for USD 31.3 billion for therapeutics and vaccine development, Jun 26; G7, second summit on COVID-19 research and innovation, Jul 1–2; G8, engaging >150 countries in financing vaccines, Jul 15; G9, outline of global vaccine procurement, Aug 6; G10, WHO guidance on vaccine allocation between and within countries, Sep 14; G11, WHO calls for vaccine manufacturers to apply for prequalification, Oct 1. HADS-A, Hospital, Anxiety and Depression Scale—Anxiety.

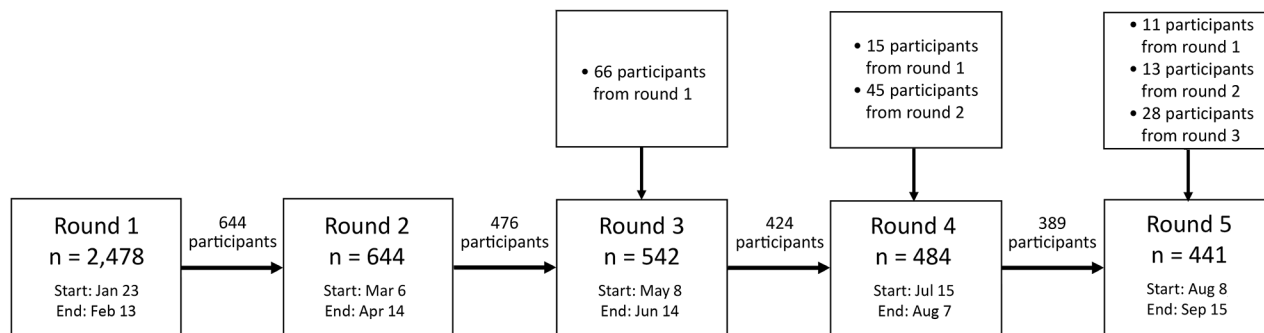


Figure 2. Timeline and participant recruitment for survey of psychobehavioral responses to the coronavirus disease pandemic, Hong Kong, 2020. To qualify for the survey, participants had to be ≥ 18 years of age and reside in Hong Kong for ≥ 5 days/week in the preceding month. The numbers in the box for each round refer to the number of respondents who indicated willingness to participate in the respective survey round; they may or may not have completed the questionnaire.

being anxious (aOR 1.47, 95% CI 1.23–1.76) (Appendix Table 7). Respondents with chronic conditions (aOR 0.72, 95% CI 0.54–0.95) and those reporting having neutral understanding of COVID-19, compared with those who said they understood COVID-19 not well/not well at all (aOR 0.73, 95% CI 0.62–0.85), were less likely to practice social distancing (Appendix Table 7).

Likelihood of COVID-19 Vaccine Uptake

Respondents' intention to receive COVID-19 vaccine decreased significantly from R4 (48.7%, 95% CI 44.0–53.4) to R5 (37.6%, 95% CI 32.9–42.4), with particularly low rates among persons ≥ 55 years of age (Appendix Table 8). Factors associated with higher tendency for receiving COVID-19 vaccines were anxiety (borderline abnormal: aOR 1.53, 95% CI 1.04–2.23; abnormal: aOR 1.87, 95% CI 1.19–2.93), complacency (aOR 0.72, 95% CI 0.62–0.85), confidence (aOR 1.71, 95% CI 1.48–1.99), and collective responsibility (aOR 1.31, 95% CI 1.10–1.55). Compared with persons 18–24 years of age, persons ≥ 55 years of age were less likely to receive COVID-19 vaccine (aOR 0.47, 95% CI 0.23–0.98) (Appendix Table 8).

We also researched the trends of other psychobehavioral responses. We compiled responses for comparing perceived severity across diseases (Appendix, Appendix Table 9), confidence in government and doctors (Appendix, Appendix Table 10), knowledge of COVID-19 (Appendix, Appendix Table 11), and perceived effectiveness of precautionary measures (Appendix, Appendix Table 2).

Discussion

Our 5-round longitudinal online survey analyzed the temporal changes in community responses throughout the first 2 COVID-19 epidemics in Hong Kong. Overall, perceived susceptibility (assuming no precautionary measure taken) remained high:

self-susceptibility (87.2%–92.8%) was substantially higher than that observed for the 2003 SARS epidemic (23.0%) (21) and the 2009 influenza pandemic (58.1%) (22) in the same population. However, in terms of perceived severity, the proportions dropped dramatically across time but were still higher than those observed in other highly affected locations (United Kingdom, 20.7% [12]; Kerala state, India, 55.7% [23]). The proportions of persons with an abnormal level of anxiety also dropped over the study period, from 34.3% to 22.0%. We observed consistently high levels of precautionary measures, such as mask wearing, hand hygiene, and home disinfection throughout the study period. Greater anxiety was associated with higher tendency of social distancing. The projected COVID-19 vaccine uptake rate dropped from 48.7% (R4) to 37.6% (R5). Greater anxiety, confidence in the vaccine, and collective responsibility and lower complacency contributed to a greater likelihood of intended vaccination.

Implications of Results

Our results have 5 immediate public health implications. First, with the uncertain disease progression (e.g., emergence of new variants of coronavirus) and the changing institutionalized interventions, there should be continual monitoring of risk perception toward COVID-19 in the community. Risk perception is an indispensable determinant of behavioral change (24) and depends on the prevalence of the health risk concerned (25). Our findings show varying risk perception over time during the pandemic, illustrating a perceived severity of COVID-19 that significantly decreased over time. Inferring from the large difference between naive (assuming no precautionary measures) and current (based on the current situation) scenarios, perceived susceptibility is sensitive to the disease progression and interventions in place.

Although such temporal trend of risk perception was also observed in past pandemics (26), the absolute level of risk perception was not.

Second, surveillance and encouragement of social distancing should be maintained in the medium to long term, given the low projected uptake rate of COVID-19 vaccine. In Hong Kong, the reproductive number peaked at 2.39 in wave 1 and 3.04 in wave 2 (20), which (based on early data) corresponded approximately to requiring 56.1%–66.9% of the population to be immune to confer herd immunity (27). Because the projected vaccine uptake rates (R4, 48.7%; R5, 37.6%) fell short of the required level, relatively small-scale upcoming epidemics compared with the previous waves are expected. With more persons being vaccinated, there might be more social interactions, so persons should be encouraged to maintain social distancing (such as avoiding unnecessary gatherings). Meanwhile, further research should focus on disease transmission during a mix of social distancing in place and vaccine hesitancy in the population.

Third, risk communications in Hong Kong should target complacency, vaccine confidence, and collective responsibility to boost the COVID-19 vaccine uptake. We reported a low intention for uptake of the would-be vaccines, which declined over time in Hong Kong. A similar situation was observed in the United States, where the projected vaccine uptake rate dropped from 74.1% in April 2020 to 56.2% in December 2020 (28). Such low uptake intention among older persons in our study (R4, 29.4%; R5, 31.4%) is particularly worrisome because older age is a risk factor for death from COVID-19 (29).

The extent to which our findings on the predictors of uptake intention can be generalized to other countries or regions requires further investigation. Unique to Hong Kong were the low COVID-19 infection rate and low level of confidence in government measures. The weak uptake intention reported in this study was uncommon compared with other countries (71.5% overall for 19 countries) (30). The low infection rate, along with the decreasing perceived severity toward COVID-19, might weaken the urgency for vaccination, which may also apply to places such as Taiwan, Japan, and Australia. However, the social unrest in Hong Kong in late 2019 might have led to distrust in the government (31), which could subsequently lower vaccination intention (32) and trigger maintenance of personal precautionary measures. One possible explanation is that, when moderated by distrust in government, persons tend to rely on personal protective measures (such as wearing facemasks and

maintaining social distancing) but become skeptical to institutional protective measures (such as vaccines). Distrust in governments during the pandemic may also influence vaccine hesitancy in other regions, such as Brazil and Poland (33). Nevertheless, given the projected low vaccine uptake rate in this study, it may be insufficient to reach herd immunity in the near future, if ever, in Hong Kong. Therefore, taking the vaccine or not may have little bearing on relaxing government interventions in the medium term. In addition, from findings in other regions, trust in the government itself (34) and the information provided by the government (30) increased preventive practices, specifically accepting vaccines, during pandemics (30). Therefore, effective health communication is particularly crucial for the Hong Kong government. To rebuild trust, public health authorities need to possess competence, objectivity, fairness, consistency, transparency, sincerity, and faith (35). In addition, organizations aside from government and healthcare providers, such as professional bodies and religious groups, may help deliver pro-vaccine messages (36).

Fourth, our results help to prioritize the content in promotional messaging. It is worth investing resources on promotional messaging, particularly when few respondents in R4 (overall, 16.7%; 18–24 y, 24.7%; 25–34 y, 14.5%; 35–44 y, 15.5%; 45–54 y, 11.5%; ≥ 55 y, 17.6%) and R5 (overall, 10.5%; 18–24 y, 12.8%; 25–34 y, 7.4%; 35–44 y, 12.1%; 45–54 y, 6.1%; ≥ 55 y, 20.0%) indicated an absolute “yes” for receiving COVID-19 vaccines (measured on a 11-point Likert scale) and when there was antibody waning after receiving the vaccine. The decreasing confidence metric from R4 to R5 highlighted the need to build trust among the public toward the logistics of vaccine development, licensing, generating recommendations, and distribution (37). Before the government authorizes the use of a COVID-19 vaccine, establishment of an advisory panel will help determine factors that the government should consider, such as performance (safety, efficacy, and effectiveness) and characteristics (number of doses, formulation, and presentation and packaging) of the available vaccine (38). Moreover, to increase the collective responsibility and perceived vaccine necessity, the government should foster understanding of the vaccine among the public with transparent communication, including more engagement with different stakeholders in the community and populations who are disproportionately affected by the pandemic to listen to their concerns. Leveraging knowledge, skills, and expertise from these communications will provide a robust assessment to underpin the vaccination campaign. Although calculations and constraints

in the 5Cs model were not associated with the vaccine uptake likelihood at this stage, continuous examination in these 2 constructs will help refine future vaccination campaigns to engage citizens in cost-benefit calculations and increase their vaccine availability, affordability and accessibility.

Fifth, the psychological distress arising from burnout should be weighed together with the well-established anxiety. This pandemic is ongoing and has lasted much longer than the SARS epidemic, so more persons are developing syndromes of emotional exhaustion. The interplay between 2 psychological distresses, burnout and anxiety, is worth investigating during the ongoing pandemic. Our study showed that almost half of respondents had burnout symptoms in a short 4-month window from June through September 2020. This symptom did not contribute to the likelihood of COVID-19 vaccination in the last 2-point survey. However, the current general measure of burnout was not able to pinpoint the sources of burnout, such as financial stress, social isolation, the disease itself, or their combinations, for a detailed analysis. Nevertheless, the burnout phenomenon among persons coping with a long-term pandemic (39) suggests the need to reexamine the temporal association among social-distancing adoption, vaccination, and burnout.

Our study's first limitation is that the survey may have been subject to recall and social conformity biases, but its longitudinal design enabled us to track the same respondents over time, reducing self-control bias. Second, caution should be exercised when generalizing our findings to other regions because Hong Kong was exposed to other disease outbreaks recently, such as 1997 avian influenza (40), 2003 SARS (41), and 2009 pandemic influenza (42). Nevertheless, our COVID-19 experience after those past outbreaks may be precedent to other countries, after the current COVID-19 pandemic. Third, our survey was conducted before the safety and efficacy data of the COVID-19 vaccines were released. The actual uptake rates might be affected by possible vaccination side effects events, such as the recent reported deaths after taking the vaccines in Hong Kong (43-45).

In conclusion, our findings highlight the importance of continuous longitudinal assessment of community psychobehavioral responses during the COVID-19 pandemic. Monitoring those responses can help public health authorities tailor health communication strategies to achieve the desired behavioral outcomes (vaccination and adoption of precautionary measures) to control future epidemic waves.

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etymologia

Clyde Partin

Sunda Pangolin [*'sün də 'paNG gōl ən*]

The Sunda or Malayan pangolin (*Manis javanica*) achieved notoriety during the coronavirus disease pandemic because of flawed evidence suggesting that pangolins could be intermediate hosts. Genetic analysis later demonstrated that the spike protein angiotensin-converting enzyme-2 receptor-binding domain of the pangolin had marginal viral avidity and thus was an unlikely infectious conduit. Pangolins are edentate mammals possessing short powerful forelimbs suitable for excavating ants and termites.

Linnaeus named the genus *Manis*, derived from *manes*, Latin for “spirits” or “ghosts or shades of the dead,” which refers to their noncuddly reptilian persona and solitary nocturnal foraging. Covered by keratin scales, pangolins, when threatened, assume a rolled up position, described by the Malay word *pengguling* (one who rolls up). Native to Java (thus *javanica*), their habitat includes Southeast Asia, especially the Indomalayan archipelago and Sunda Islands. Humans hunt pangolins for their meat, consume their blood as an elixir, and use their scales and other body parts as ingredients for crafting leather products and nonefficacious medications.



Figure. Covered in tough keratin scales interspersed with strands of fur, the pangolin, also known as a scaly anteater, assumes an impenetrable rolled-up position when threatened. Note the short muscular forelimbs. Pangolins are endangered and World Pangolin Day is the third Saturday in February. Photo of a young Chinese pangolin (*Manis pentadactyla*) by Te-Chuan Chan (Taipei Zoo, Taiwan) and Wen-Ta Li (Pangolin International Biomedical Consultant Ltd., Taiwan)

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Psychobehavioral Responses and Likelihood of Receiving COVID-19 Vaccines during the Pandemic, Hong Kong

Appendix

Additional Demographic Details of Study Cohort

In the 14 days before the survey, the proportion of subjects attending medical consultation remained at 15.1%–18.1%, but the proportion of respondents who had respiratory symptoms dropped by almost half, from 23.9% (R1) to 12.6% (R5) (Appendix Table 4). Since R1, the proportion of subjects paying an outbound visit has plummeted, from 23.8% (R1) to 0% (R5) (Appendix Table 4).

Comparison of Perceived Severity across Noncommunicable Diseases and Infectious Diseases

The perceived severity of COVID-19 was also delineated together with other diseases (Appendix Table 9). In general, participants consistently regarded COVID-19 (95.5%–99.5%) as being as serious as 2003 severe acute respiratory syndrome (97.4%–99.2%), acquired immunodeficiency syndrome (93.8%–97.5%), heart diseases (94.2%–98.1%), and cancer (95.9%–98.8%). It stood out from the annually circulating seasonal influenza (54.4%–66.6%) and the 2009 pandemic influenza (78.4%–87.7%).

Confidence in Government and Doctors over Time

Participants' confidence in the local government's adopted measures, ability and decisiveness to deal with COVID-19, and, in general, the ability to manage major crises remained relatively low during the epidemic periods (Appendix Table 10). The proportion of participants who were confident in the COVID-19 information provided by the local government

varied significantly ($p < 0.001$), ranging from 6.5% to 13.5%. On the contrary, subjects' confidence in doctors' ability to diagnose COVID-19 remained high, and increased substantially, from 53.3% (R1) to 69.6% (R5) ($p < 0.001$).

Knowledge about COVID-19 over Time

Almost all respondents paid continued attention to the COVID-19 progress throughout the first 2 waves of epidemics in Hong Kong (96.6%–99.4%), but the proportion of subjects who took the initiative to search for COVID-19 information dropped from the initial 83.2% (R1) to as low as 64.1% (R3) during the quiescence between 2 epidemic waves (Appendix Table 11). As time passed, the proportion of respondents who regarded themselves as not understanding COVID-19 well increased from the initial 64.8% (R1) to 94.9% (R5) (Appendix Table 11).

Over time, decreasing trends were observed in the percentage of respondents who identified eating game (wild animals) (R1, 92.6% to R5, 73.4%; $p < 0.001$), going to wet markets (R1, 80.8% to R5, 72.7%; $p < 0.001$), eating seafood imported from Wuhan (R1, 72.4% to R5, 55.1%; $p < 0.001$), and eating other products from Wuhan (R1, 66.5% to R5, 51.2%; $p < 0.001$) as likely routes of transmission of COVID-19. The proportion of respondents who regarded droplets as a likely route of transmission remained high (R1, 98.5% to R5, 98.1%) throughout the study but the trend was not found to be significant ($p = 0.45$). A significant increase in the number of respondents to recognize aerosol as a route of transmission was found (R1, 88.6% to R5, 90.9%; $p = 0.01$) (Appendix Table 11).

Perceived Effectiveness of Precautionary Measures

Almost all participants (>90%) felt that wearing masks, washing hands frequently with hand sanitizer or alcohol gel, disinfecting homes, covering mouth and nose when coughing and sneezing, avoiding contact with persons with respiratory disease symptoms, and avoiding going to crowded places were effective or very effective precautionary measures (Appendix Table 2) throughout the study. Relatively smaller proportions of respondents considered avoiding public transportation (R1, 76.1% to R5, 78.9%, with no significant time trend [$p = 0.28$]) and the wet market (R1, 69.9% to R5, 79.2%, with an increasing trend across waves [$p < 0.001$]) were very effective or effective measures (Appendix Table 2).

Appendix Table 1. Adoption of precautionary measures, Hong Kong, 2020

Precautionary measures	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Personal hygiene											
Wear mask											0.09
Yes	2,095	99.0	619	99.4	527	99.6	461	99.1	426	99.8	
No/not applicable	21	1.0	4	0.6	2	0.4	4	0.9	1	0.2	
Wash hands frequently (use hand sanitizer/alcohol gel)											0.03
Yes	2,027	95.8	614	98.6	522	98.7	452	97.2	417	97.7	
No/not applicable	89	4.2	9	1.4	7	1.3	13	2.8	10	2.3	
Disinfect home											0.00
Yes	1,663	78.6	560	89.9	469	88.7	411	88.4	378	88.5	
No/not applicable	453	21.4	63	10.1	60	11.3	54	11.6	49	11.5	
Cover mouth and nose when coughing or sneezing											0.13
Yes	2,051	96.9	612	98.2	519	98.1	451	97.0	420	98.4	
No/not applicable	65	3.1	11	1.8	10	1.9	14	3.0	7	1.6	
Social distancing											
Avoid contact with persons with fever or symptoms of respiratory diseases											0.05
Yes	1,965	92.9	597	95.8	497	94.0	438	94.2	406	95.1	
No/not applicable	151	7.1	26	4.2	32	6.0	27	5.8	21	4.9	
Avoid contact with persons who have been to Wuhan in the past month											0.00
Yes	1,781	84.2	544	87.3	423	80.0	361	77.6	308	72.1	
No/not applicable	335	15.8	79	12.7	106	20.0	104	22.4	119	27.9	
Avoid going out											0.00
Yes	1,445	68.3	494	79.3	389	73.5	360	77.4	322	75.4	
No/not applicable	671	31.7	129	20.7	140	26.5	105	22.6	105	24.6	
Avoid going to crowded places											0.40
Yes	1,845	87.2	571	91.7	460	87.0	425	91.4	372	87.1	
No/not applicable	271	12.8	52	8.3	69	13.0	40	8.6	55	12.9	
Avoid going to wet market											0.08
Yes	1,456	68.8	396	63.6	290	54.8	307	66.0	284	66.5	
No/not applicable	660	31.2	227	36.4	239	45.2	158	34.0	143	33.5	
Avoid going to hospital/clinic											0.00
Yes	1,605	75.9	503	80.7	373	70.5	334	71.8	294	68.9	
No/not applicable	511	24.1	120	19.3	156	29.5	131	28.2	133	31.1	
Avoid public transportation											0.11
Yes	805	38.0	272	43.7	168	31.8	169	36.3	152	35.6	
No/not applicable	1,311	62.0	351	56.3	361	68.2	296	63.7	275	64.4	
Avoid work											0.00
Yes	521	24.6	238	38.2	139	26.3	162	34.8	151	35.4	
No/not applicable	1,595	75.4	385	61.8	390	73.7	303	65.2	276	64.6	
Avoid social activities											0.00
Yes	1,350	63.8	519	83.3	395	74.7	400	86.0	366	85.7	
No/not applicable	766	36.2	104	16.7	134	25.3	65	14.0	61	14.3	
Travel avoidance											
Avoid going to Wuhan											0.00
Yes	1,895	89.6	538	86.4	406	76.7	335	72.0	288	67.4	
No/not applicable	221	10.4	85	13.6	123	23.3	130	28.0	139	32.6	
Avoid going to Hubei province											0.00

Precautionary measures	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Yes	1,894	89.5	538	86.4	406	76.7	338	72.7	288	67.4	0.00
No/not applicable	222	10.5	85	13.6	123	23.3	127	27.3	139	32.6	
Avoid going to mainland China											0.08
Yes	1,942	91.8	566	90.9	431	81.5	363	78.1	314	73.5	
No/not applicable	174	8.2	57	9.1	98	18.5	102	21.9	113	26.5	
Leave Hong Kong temporarily											0.08
Yes	205	9.7	53	8.5	44	8.3	54	11.6	56	13.1	
No/not applicable	1,911	90.3	570	91.5	485	91.7	441	88.4	371	86.9	

Appendix Table 2. Perceived effectiveness of precautionary measures to prevent COVID-19, Hong Kong, 2020

Precautionary measures	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Wear mask											0.00
Very effective/effective	1,988	94.0	604	97.0	521	98.5	459	98.7	422	98.8	
Neutral/not effective/not very effective	128	6.0	19	3.0	8	1.5	6	1.3	5	1.2	0.00
Wash hands frequently (use hand sanitizer/alcohol gel)											
Very effective/effective	2,038	96.3	611	98.1	525	99.2	462	99.4	425	99.5	0.00
Neutral/not effective/not very effective	78	3.7	12	1.9	4	0.8	3	0.6	2	0.5	
Disinfect home											0.00
Very effective/effective	1,910	90.3	595	95.5	512	96.8	448	96.3	411	96.3	
Neutral/not effective/not very effective	206	9.7	28	4.5	17	3.2	17	3.7	16	3.7	0.00
Cover mouth and nose when coughing or sneezing											
Very effective/effective	1,917	90.6	597	95.8	509	96.2	454	97.6	412	96.5	0.00
Neutral/not effective/not very effective	199	9.4	26	4.2	20	3.8	11	2.4	15	3.5	
Avoid contact with persons with fever or symptoms of respiratory diseases											0.00
Very effective/effective	2,045	96.6	616	98.9	522	98.7	460	98.9	421	98.6	
Neutral/not effective/not very effective	71	3.4	7	1.1	7	1.3	5	1.1	6	1.4	0.00
Avoid contact with persons who have been to Wuhan in the past month											
Very effective/effective	2,047	96.7	610	97.9	502	94.9	415	89.2	378	88.5	0.00
Neutral/not effective/not very effective	69	3.3	13	2.1	27	5.1	50	10.8	49	11.5	
Avoid going out											0.00
Very effective/effective	1,720	81.3	545	87.5	442	83.6	425	91.4	381	89.2	
Neutral/not effective/not very effective	396	18.7	78	12.5	87	16.4	40	8.6	46	10.8	0.00
Avoid going to crowded places											
Very effective/effective	1,943	91.8	603	96.8	491	92.8	448	96.3	411	96.3	0.00
Neutral/not effective/not very effective	173	8.2	20	3.2	38	7.2	17	3.7	16	3.7	
Avoid going to wet market											0.00
Very effective/effective	1,479	69.9	418	67.1	326	61.6	353	75.9	338	79.2	
Neutral/not effective/not very effective	637	30.1	205	32.9	203	38.4	112	24.1	89	20.8	0.01
Avoid going to hospital/clinic											
Very effective/effective	1,846	87.2	542	87.0	418	79.0	395	84.9	356	83.4	0.01
Neutral/not effective/not very effective	270	12.8	81	13.0	111	21.0	70	15.1	71	16.6	
Avoid public transportation											0.28
Very effective/effective	1,610	76.1	506	81.2	375	70.9	370	79.6	337	78.9	
Neutral/not effective/not very effective	506	23.9	117	18.8	154	29.1	95	20.4	90	21.1	

Precautionary measures	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Avoid work											0.00
Very effective/effective	1,453	68.7	485	77.8	368	69.6	379	81.5	338	79.2	
Neutral/not effective/not very effective	663	31.3	138	22.2	161	30.4	86	18.5	89	20.8	
Avoid social activities											0.00
Very effective/effective	1,602	75.7	560	89.9	438	82.8	432	92.9	389	91.1	
Neutral/not effective/not very effective	514	24.3	63	10.1	91	17.2	33	7.1	38	8.9	
Avoid going to Wuhan											0.00
Very effective/effective	2,070	97.8	612	98.2	505	95.5	426	91.6	378	88.5	
Neutral/not effective/not very effective	46	2.2	11	1.8	24	4.5	39	8.4	49	11.5	
Avoid going to Hubei province											0.00
Very effective/effective	2,075	98.1	613	98.4	506	95.7	422	90.8	379	88.8	
Neutral/not effective/not very effective	41	1.9	10	1.6	23	4.3	43	9.2	48	11.2	
Avoid going to mainland China											0.00
Very effective/effective	2,057	97.2	612	98.2	504	95.3	429	92.3	382	89.5	
Neutral/not effective/not very effective	59	2.8	11	1.8	25	4.7	36	7.7	45	10.5	
Leave Hong Kong temporarily											0.00
Very effective/effective	618	29.2	88	14.1	75	14.2	90	19.4	92	21.5	
Neutral/not effective/not very effective	1,498	70.8	535	85.9	454	85.8	375	80.6	335	78.5	

Appendix Table 3. Demographic characteristics of study participants, Hong Kong, 2020

Demographic characteristic*	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)	
	n	%	n	%	n	%	n	%	n	%
Sex										
Male	734	31.5	198	30.7	167	30.8	146	30.2	139	31.5
Female	1,594	68.5	446	69.3	375	69.2	338	69.8	302	68.5
Age, y										
18–24	588	25.3	131	20.3	107	19.7	100	20.7	90	20.4
25–34	750	32.2	220	34.2	188	34.7	172	35.5	158	35.8
35–44	513	22.0	156	24.2	131	24.2	120	24.8	105	23.8
45–54	263	11.3	83	12.9	66	12.2	54	11.2	52	11.8
≥55	214	9.2	54	8.4	50	9.2	38	7.9	36	8.2
Educational attainment										
Junior high school or below	58	3.4	15	2.3	9	1.7	7	1.4	9	2.0
High school	305	17.7	107	16.6	86	15.9	80	16.5	68	15.4
Postsecondary	1,136	66.0	418	64.9	351	64.8	326	67.4	294	66.7
Graduate school or above	221	12.8	104	16.1	96	17.7	71	14.7	70	15.9
Presence of domestic helper at home										
Yes	209	12.2	87	13.5	72	13.3	62	12.8	59	13.4
No	1,507	87.8	557	86.5	470	86.7	422	87.2	382	86.6
Presence of children at home										

Demographic characteristic*	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)	
	n	%	n	%	n	%	n	%	n	%
Yes	462	26.9	192	29.8	164	30.3	145	30.0	140	31.7
No	1,254	73.1	452	70.2	378	69.7	339	70.0	301	68.3
Total monthly household income (Hong Kong dollars [HKD])										
≤10,000 or below	104	6.1	25	3.9	24	4.4	19	3.9	18	4.1
10,001–20,000†	277	16.2	95	14.8	68	12.5	68	14.0	65	14.7
20,001–30,000	297	17.3	125	19.4	100	18.5	85	17.6	84	19.0
30,001–40,000	233	13.6	97	15.1	89	16.4	87	18.0	72	16.3
40,001–50,000	162	9.4	61	9.5	56	10.3	50	10.3	45	10.2
50,001–60,000	128	7.5	57	8.9	47	8.7	41	8.5	42	9.5
>60,000	257	15.0	118	18.3	102	18.8	86	17.8	77	17.5
Not disclosed	257	15.0	66	10.2	56	10.3	48	10.0	38	8.6
District of residence										
Hong Kong Island	400	17.2	101	15.8	87	16.1	73	15.2	76	17.4
Kowloon East	392	16.8	111	17.3	79	14.6	85	17.7	72	16.4
Kowloon West	168	7.2	52	8.1	46	8.5	38	7.9	33	7.5
New Territories East	734	31.5	201	31.4	171	31.6	150	31.3	138	31.5
New Territories West	633	27.2	175	27.3	159	29.3	134	27.9	119	27.2

*Demographic data for rounds 2–5 were retrieved from data in round 1, except for district of residence.

†In the survey this option was shown as “HKD 10,000–HKD 20,000.”

Appendix Table 4. Background health conditions and travel history of participants, Hong Kong, 2020

Condition	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)	
	n	%	n	%	n	%	n	%	n	%
Background health conditions										
Present smoker*										
Yes†	217	8.9	54	8.4	40	7.4	41	8.5	36	8.2
No‡	2,211	91.1	590	91.6	502	92.6	443	91.5	405	91.8
Presence of chronic disease*										
Yes	192	11.2	83	12.9	66	12.2	58	12.0	51	11.6
No	1,523	88.8	561	87.1	476	87.8	426	88.0	390	88.4
Self-perceived health condition										
Excellent/good	1,870	77.0	499	78.1	418	77.3	350	73.1	335	76.8
Bad/very bad	517	21.3	129	20.2	109	20.1	113	23.6	88	20.2
Fair	41	1.7	11	1.7	14	2.6	16	3.3	13	3.0
Medical consultation in past 14 d										
Yes	418	17.2	109	17.1	98	18.1	86	18.0	66	15.1
No	2,010	82.8	530	82.9	443	81.9	393	82.0	370	84.9
Presence of respiratory symptom(s) in past 14 d										
Yes	581	23.9	115	18.0	58	10.7	77	16.1	55	12.6

Condition	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)	
	n	%	n	%	n	%	n	%	n	%
No	1,847	76.1	524	82.0	483	89.3	402	83.9	381	87.4
Travel history										
Regular visits to mainland China*										
Yes	72	3.0	21	3.3	20	3.7	18	3.7	13	2.9
No	2,346	97.0	623	96.7	522	96.3	466	96.3	428	97.1
Leave Hong Kong in past month										
Yes	575	23.8	40	6.3	2	0.4	2	0.4	0	0
No	1,844	76.2	598	93.7	538	99.6	477	99.6	434	100

*Demographic data for rounds 2–5 were retrieved from data in round 1, except for district of residence.

†Regular and social smoker.

‡Nonsmoker (quit smoking for >1 mo) and never-smoker.

Appendix Table 5. Risk perception toward COVID-19, Hong Kong, 2020

Condition	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Perceived susceptibility (assuming no precautionary measures)											
Self											0.03
Very likely/likely	2,039	87.2	579	91.3	470	87.9	437	92.8	384	89.3	
Neutral/unlikely/very unlikely	298	12.8	55	8.7	65	12.1	34	7.2	46	10.7	
Family members											0.08
Very likely/likely	2,122	90.8	600	94.6	487	91.0	446	94.7	397	92.3	
Neutral/unlikely/very unlikely	215	9.2	34	5.4	48	9.0	25	5.3	33	7.7	
Perceived susceptibility (based on current situation)											
Self											0.00
Very high/high	NA*	NA	NA	NA	103	19.3	198	42.0	144	33.5	
Neutral/small/very small	NA	NA	NA	NA	432	80.7	273	58.0	286	66.5	
Family members											0.00
Very high/high	NA	NA	NA	NA	104	19.4	217	46.1	153	35.6	
Neutral/small/very small	NA	NA	NA	NA	431	80.6	254	53.9	277	64.4	
Perceived severity											
Perceived severity of COVID-19											0.00
Very serious/serious	2,266	97.4	595	93.8	471	88.0	387	82.2	332	77.2	
Neutral/not serious/not serious at all	61	2.6	39	6.2	64	12.0	84	17.8	98	22.8	
Perceived chance of having COVID-19 cured											0.00
Very high/high	386	16.6	228	36.0	239	44.7	257	54.6	246	57.2	
Neutral/low/very low	1,941	83.4	406	64.0	296	55.3	214	45.4	184	42.8	
Perceived survival chance of COVID-19											0.00
Very high/high	432	18.6	289	45.6	309	57.8	310	65.8	289	67.2	
Neutral/low/very low	1,895	81.4	345	54.4	226	42.2	161	34.2	141	32.8	

*NA, not applicable.

Appendix Table 6. Worry and burnout of participants, Hong Kong, 2020*

Characteristic	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Anxiety (general)											
Anxiety level by HADS-A											0.00
Normal	850	35.6	233	36.6	264	49.1	209	44.2	223	51.7	
Borderline	719	30.1	201	31.6	142	26.4	136	28.8	113	26.2	
Abnormal	819	34.3	202	31.8	132	24.5	128	27.1	95	22.0	
Anxiety (COVID-19 specific)											
Effect of COVID-19 on daily life											0.57
A little/not at all/do not know	1,074	44.5	254	39.8	292	54.3	182	38.2	182	42.0	
A lot	1,338	55.5	384	60.2	246	45.7	294	61.8	251	58.0	
Worried about COVID-19											0.00
Yes	2,335	96.8	597	93.6	461	85.7	440	92.4	377	87.1	
No	77	3.2	41	6.4	77	14.3	36	7.6	56	12.9	
Fear of contracting COVID-19 in public places											0.00
Very afraid/afraid/neutral	2,351	97.8	622	97.7	503	93.5	453	95.2	406	94.0	
Not afraid/not afraid at all	53	2.2	15	2.4	35	6.5	23	4.8	26	6.0	
Frequency of thinking of COVID-19											0.00
Always (could not fall asleep)/very often/often	1,831	76.2	431	67.7	262	48.7	285	59.9	210	48.6	
Sometimes/never	573	23.8	206	32.3	276	51.3	191	40.1	222	51.4	
Burnout											
Presence of burnout symptoms											0.53
Yes	NA	NA	NA	NA	195	37.6	180	39.6	168	40.1	
No	NA	NA	NA	NA	324	62.4	274	60.4	251	59.9	

*HADS-A, Hospital, Anxiety, and Depression Scale--Anxiety; NA, not applicable.

Appendix Table 7. Proportion of participants with higher tendency of social distancing, and factors associated with such higher tendency, Hong Kong, 2020

Characteristic	Round 1		Round 2		Round 3		Round 4		Round 5		p (trend)	Higher tendency of social distancing		
	n	Proportion % (95% CI)	n	Proportion % (95% CI)	n	Proportion % (95% CI)	n	Proportion % (95% CI)	n	Proportion % (95% CI)		aOR (95% CI)	p value	
Overall	1,715	48.5 (46.1–50.9)	623	55.7 (51.7–59.6)	529	45.6 (41.3–49.9)	465	52.3 (47.6–56.9)	427	52.7 (47.8–57.5)	0.09	NA	NA	NA
Sex														
Male	539	43.4 (39.2–47.7)	190	51.1 (43.7–58.3)	161	37.3 (29.9–45.3)	140	50.7 (42.2–59.2)	133	50.4 (41.6–59.1)	0.06	NA	NA	NA
Female	1176	50.9 (48.0–53.7)	433	57.7 (52.9–62.4)	368	49.2 (44.0–54.4)	325	52.9 (47.3–58.4)	294	53.7 (47.9–59.5)	0.47	1.30	(1.09–1.56)	0.00
Age, y														
18–24	441	46.5 (41.8–51.3)	124	65.3 (56.2–73.5)	106	47.2 (37.5–57.1)	96	51.0 (40.7–61.3)	86	58.1 (47.0–68.5)	0.05	NA	NA	NA
25–34	558	52.3 (48.1–56.5)	214	55.1 (48.2–61.9)	184	47.8 (40.5–55.3)	168	54.2 (46.3–61.8)	150	56.0 (47.7–64.0)	0.24	1.18	(0.94–1.47)	0.15
35–44	381	48.0 (42.9–53.2)	153	55.6 (47.3–63.5)	126	50.0 (41.4–58.6)	112	58.0 (48.3–67.2)	103	46.6 (36.8–56.7)	0.51	1.11	(0.88–1.42)	0.38
45–54	197	49.2 (42.1–56.4)	79	45.6 (34.5–57.1)	65	35.4 (24.2–48.3)	53	47.2 (33.5–61.2)	52	50.0 (36.9–63.1)	0.48	1.06	(0.78–1.42)	0.72
55 or above	138	39.9 (31.7–48.6)	53	50.9 (37.0–64.7)	48	35.4 (22.6–50.6)	36	36.1 (21.3–53.8)	36	47.2 (30.8–64.3)	0.97	0.82	(0.57–1.17)	0.26
Living district														
Hong Kong Island	307	42.0 (36.5–47.8)	96	54.2 (43.7–64.3)	85	36.5 (26.5–47.7)	72	38.9 (27.8–51.1)	73	49.3 (37.5–61.2)	0.26	NA	NA	NA
Kowloon East	268	42.5 (36.6–48.7)	107	53.3 (43.4–62.9)	78	43.6 (32.6–55.3)	83	60.2 (48.9–70.6)	70	50.0 (38.6–61.4)	0.07	1.01	(0.76–1.33)	0.96
Kowloon West	128	41.4 (32.9–50.5)	52	59.6 (45.1–72.7)	45	55.6 (40.1–70.0)	37	56.8 (39.6–72.5)	32	50.0 (33.6–66.4)	0.05	1.20	(0.85–1.68)	0.31
New Territories East	541	54.3 (50.0–58.6)	196	57.1 (49.9–64.1)	167	44.9 (37.3–52.8)	145	52.4 (44.0–60.7)	136	51.5 (42.8–60.1)	0.11	1.40	(1.10–1.80)	0.01
New Territories West	471	51.4 (46.8–56.0)	172	55.2 (47.5–62.7)	154	49.4 (41.3–57.5)	128	53.1 (44.1–61.9)	116	58.6 (49.1–67.6)	0.09	1.42	(1.11–1.82)	0.01
Perceived understanding of COVID-19														
Not well/ not well at all	173	41.6 (34.3–49.4)	291	58.4 (52.5–64.1)	245	47.3 (41.0–53.8)	229	54.1 (47.5–60.7)	233	53.2 (46.6–59.7)	0.24	NA	NA	NA
Neutral	908	44.2 (40.9–47.5)	297	52.5 (46.7–58.3)	248	40.7 (34.6–47.1)	212	50.0 (43.3–56.7)	172	52.3 (44.6–59.9)	0.13	0.73	(0.62–0.85)	0.00
Well/ very well	634	56.6 (52.7–60.5)	35	60.0 (42.2–75.6)	36	66.7 (48.9–80.9)	24	54.2 (33.2–73.8)	22	50.0 (30.7–69.3)	0.85	1.02	(0.85–1.22)	0.85
Presence of chronic conditions														
No	1,523	49.2 (46.7–51.8)	544	58.1 (53.8–62.3)	463	47.7 (43.1–52.4)	407	55.0 (50.1–59.9)	377	53.6 (48.4–58.7)	0.07	NA	NA	NA
Yes	192	42.7 (35.7–50.0)	79	39.2 (28.6–50.9)	66	30.3 (19.9–43.0)	58	32.8 (21.4–46.5)	50	46.0 (32.1–60.5)	0.98	0.72	(0.54–0.95)	0.02
Anxiety level														
Normal	607	40.7 (36.8–44.7)	230	50.0 (43.6–56.4)	258	38.4 (32.5–44.6)	205	47.3 (40.4–54.4)	220	48.2 (41.4–55.0)	0.06	NA	NA	NA
Borderline abnormal	527	49.7 (45.4–54.1)	196	53.6 (46.3–60.7)	140	42.9 (34.6–51.5)	134	50.0 (41.7–58.3)	112	55.4 (45.7–64.7)	0.66	1.05	(0.89–1.23)	0.59
Abnormal	581	55.6 (51.4–59.7)	197	64.5 (57.3–71.1)	131	62.6 (53.7–70.8)	126	62.7 (53.6–71.0)	95	60.0 (49.4–69.8)	0.04	1.47	(1.23–1.76)	0.00
Confidence in government measures														
Very confident to neutral	108	36.1 (27.3–46.0)	77	59.7 (47.9–70.6)	134	38.8 (30.6–47.6)	64	53.1 (40.3–65.5)	56	53.6 (39.9–66.8)	0.11	NA	NA	NA
Not confident/ not confident at all	1,607	49.3 (46.9–51.8)	546	55.1 (50.8–59.3)	395	47.8 (42.8–52.9)	401	52.1 (47.1–57.1)	371	52.6 (47.3–57.7)	0.22	1.03	(0.84–1.27)	0.78

*aOR, adjusted odds ratio; NA, not applicable.

Appendix Table 8. Proportion of potential vaccine recipients and factors associated with higher uptake tendency of COVID-19 vaccines, Hong Kong, 2020*

Characteristics	Round 4			Round 5			Temporal variation (difference in proportion)			Higher uptake tendency		
	n	%	95% CI	n	%	95% CI	%	95% CI	p value†	aOR	95% CI	p value
Overall	454	48.7	(44.0–53.4)	418	37.6	(32.9–42.4)	-11.1	(-16.1 to -6.2)	0.00	NA	NA	NA
Sex												
Male	136	53.7	(44.9–62.2)	132	40.9	(32.5–49.8)	-12.8	(-22.0 to -3.6)	0.01	NA	NA	NA
Female	318	46.5	(41.0–52.2)	286	36.0	(30.5–41.9)	-10.5	(-16.4 to -4.7)	0.00	0.87	(0.59–1.28)	0.48
Age, y												
18–24	93	59.1	(48.4–69.1)	86	46.5	(35.8–57.5)	-12.6	(-22.6 to -2.6)	0.01	-	-	-
25–34	165	50.9	(43.1–58.7)	149	37.6	(29.9–45.9)	-13.3	(-21.7 to -4.9)	0.00	0.79	(0.48–1.30)	0.35
35–44	110	46.4	(36.9–56.1)	99	37.4	(28.0–47.7)	-9.0	(-19.1 to 1.1)	0.08	0.87	(0.51–1.48)	0.62
45–54	52	40.4	(27.3–54.9)	49	26.5	(15.4–41.3)	-13.9	(-28.5 to 0.8)	0.06	0.59	(0.29–1.21)	0.15
≥55	34	29.4	(15.7–47.7)	35	31.4	(17.4–49.4)	2.0	(-15.8 to 19.8)	0.82	0.47	(0.23–0.98)	0.04
District of residence												
Hong Kong Island	69	43.5	(31.8–55.9)	72	27.8	(18.2–39.8)	-15.7	NA	NA	NA	NA	NA
Kowloon East	82	53.7	(42.4–64.6)	70	37.1	(26.1–49.6)	-16.5	NA	NA	1.56	(0.86–2.85)	0.14
Kowloon West	36	47.2	(30.8–64.3)	32	34.4	(19.2–53.2)	-12.8	NA	NA	1.08	(0.50–2.34)	0.84
New Territories E	141	48.9	(40.5–57.5)	132	37.1	(29.0–46.0)	-11.8	NA	NA	1.26	(0.73–2.17)	0.41
New Territories W	126	48.4	(39.5–57.4)	112	45.5	(36.2–55.2)	-2.9	NA	NA	1.57	(0.90–2.75)	0.11
Perceived understanding of COVID-19												
Not well/not well at all	226	53.1	(46.4–59.7)	229	38.9	(32.6–45.5)	-14.2	NA	NA	NA	NA	NA
Neutral	204	42.2	(35.4–49.3)	168	36.9	(29.7–44.7)	-5.3	NA	NA	1.13	(0.80–1.61)	0.48
Well or very well	24	62.5	(40.8–80.4)	21	28.6	(12.2–52.3)	-33.9	NA	NA	1.11	(0.56–2.21)	0.76
Presence of chronic conditions												
No	399	48.1	(43.1–53.1)	370	36.2	(31.4–41.4)	-11.9	(-17.1 to -6.8)	0.00	NA	NA	NA
Yes	55	52.7	(38.9–66.1)	48	47.9	(33.5–62.6)	-4.8	(-21.3 to 11.7)	0.57	1.55	(0.88–2.74)	0.13
Anxiety level												
Normal	200	42.5	(35.6–49.7)	215	32.6	(26.4–39.3)	-9.9	NA	NA	NA	NA	NA
Borderline abnormal	130	51.5	(42.7–60.3)	110	41.8	(32.6–51.6)	-9.7	NA	NA	1.53	(1.04–2.23)	0.03
Abnormal	124	55.6	(46.5–64.5)	93	44.1	(33.9–54.7)	-11.6	NA	NA	1.87	(1.19–2.93)	0.01
Confidence in government measures												
Very confident/neutral	63	44.4	(32.1–57.4)	55	40.0	(27.3–54.1)	-4.4	NA	NA	NA	NA	NA
Not confident/not confident at all	391	49.4	(44.3–54.4)	363	37.2	(32.2–42.4)	-12.2	NA	NA	0.97	(0.61–1.55)	0.90
Presence of symptoms of burnout												
No	274	45.6	(39.6–51.7)	250	33.2	(27.5–39.5)	-12.4	NA	NA	NA	NA	NA
Yes	180	53.3	(45.8–60.7)	168	44.0	(36.5–51.9)	-9.3	NA	NA	1.18	(0.84–1.67)	0.34
Vaccine hesitancy, mean (SD)												
Complacency	454	3.20	(1.19)	418	3.20	(1.27)	NA	NA	NA	0.72	(0.62–0.85)	0.00
Constraint	454	2.92	(1.28)	418	2.97	(1.25)	NA	NA	NA	0.90	(0.78–1.05)	0.18
Calculation	454	5.64	(0.96)	418	5.78	(0.88)	NA	NA	NA	0.87	(0.72–1.05)	0.15
Confidence	454	4.60	(1.19)	418	4.42	(1.30)	NA	NA	NA	1.71	(1.48–1.99)	0.00
Collective	454	5.46	(1.16)	418	5.52	(1.16)	NA	NA	NA	1.31	(1.10–1.55)	0.00

*aOR, adjusted odds ratio; NA, not applicable; SD, standard deviation.

†Based on the partially overlapping samples z-test; valid only for non-time-varying participant characteristics.

Appendix Table 9. Comparison of diseases in terms of perceived severity, Hong Kong, 2020

Diseases	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Emerging infectious diseases											
COVID-19											0.00
Very bad/bad	2,061	98.8	620	99.5	523	98.9	442	95.5	407	95.8	
Neutral/not bad/not bad at all	26	1.2	3	0.5	6	1.1	21	4.5	18	4.2	
Existing infectious diseases											
Seasonal influenza											0.00
Very bad/bad	1,389	66.6	377	60.5	334	63.1	252	54.4	255	60.0	
Neutral/not bad/not bad at all	698	33.4	246	39.5	195	36.9	211	45.6	170	40.0	
2009 influenza pandemic											0.00
Very bad/bad	1,830	87.7	525	84.3	444	83.9	367	79.3	333	78.4	
Neutral/not bad/not bad at all	257	12.3	98	15.7	85	16.1	96	20.7	92	21.6	
2003 SARS											0.28
Very bad/bad	2,051	98.3	618	99.2	518	97.9	454	98.1	414	97.4	
Neutral/not bad/not bad at all	36	1.7	5	0.8	11	2.1	9	1.9	11	2.6	
Noncommunicable diseases											
Diabetes											0.00
Very bad/bad	1,772	84.9	576	92.5	494	93.4	422	91.1	397	93.4	
Neutral/not bad/not bad at all	315	15.1	47	7.5	35	6.6	41	8.9	28	6.6	
Cancer											0.00
Very bad/bad	2,002	95.9	612	98.2	518	97.9	455	98.3	420	98.8	
Neutral/not bad/not bad at all	85	4.1	11	1.8	11	2.1	8	1.7	5	1.2	
Heart disease											0.00
Very bad/bad	1,966	94.2	606	97.3	519	98.1	453	97.8	414	97.4	
Neutral/not bad/not bad at all	121	5.8	17	2.7	10	1.9	10	2.2	11	2.6	
AIDS											0.01
Very bad/bad	1,957	93.8	602	96.6	516	97.5	447	96.5	406	95.5	
Neutral/not bad/not bad at all	130	6.2	21	3.4	13	2.5	16	3.5	19	4.5	

Appendix Table 10. Confidence in the local government and doctors, Hong Kong, 2020

Area	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Confidence in the local government											
COVID-19 information provided											0.00
Very confident/confident	148	6.5	59	9.4	72	13.5	60	12.8	48	11.2	
Neutral/not confident/not confident at all	2,117	93.5	571	90.6	462	86.5	409	87.2	380	88.8	
Measures taken in response to COVID-19											0.07
Very confident/confident	58	2.6	17	2.7	33	6.2	16	3.4	11	2.6	
Neutral/not confident/not confident at all	2,207	97.4	613	97.3	501	93.8	453	96.6	417	97.4	
Ability to deal with COVID-19											0.59
Very confident/confident	74	3.3	20	3.2	36	6.7	13	2.8	13	3.0	
Neutral/not confident/not confident at all	2,191	96.7	610	96.8	498	93.3	456	97.2	415	97.0	
Decisiveness in dealing with COVID-19											0.16
Very confident/confident	31	1.4	10	1.6	21	3.9	7	1.5	7	1.6	
Neutral/not confident/not confident at all	2,234	98.6	620	98.4	513	96.1	462	98.5	421	98.4	
Itself, apart from ability to manage major crises											0.45
Very confident/confident	47	2.1	15	2.4	16	3.0	9	1.9	11	2.6	
Neutral/not confident/not confident at all	2,218	97.9	615	97.6	518	97.0	460	98.1	417	97.4	
Confidence in doctors											
Ability to diagnose COVID-19											0.00
Very confident/confident	1,171	53.3	349	55.6	352	66.3	302	64.7	298	69.6	
Neutral/not confident/not confident at all	1,025	46.7	279	44.4	179	33.7	165	35.3	130	30.4	

Appendix Table 11. Knowledge of route of transmission of COVID-19, Hong Kong, 2020

Knowledge level	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Keep an eye on COVID-19 progress											
Yes	2,309	99.4	625	98.7	517	96.6	463	98.5	419	97.4	0.00
No	15	0.6	8	1.3	18	3.4	7	1.5	11	2.6	
Actively search for COVID-19 information											0.00
Yes	1,933	83.2	500	79.0	343	64.1	353	75.1	301	70.0	
No	391	16.8	133	21.0	192	35.9	117	24.9	129	30.0	
Understanding of COVID-19											0.00
Very well/well	763	35.2	35	5.6	36	6.8	24	5.1	22	5.1	
Neutral/Not well/Not well at all	1,403	64.8	591	94.4	493	93.2	443	94.9	406	94.9	
COVID-19 Infection likelihood for the following routes											
Talk to an asymptomatic infected person without physical touch											0.91
Very likely/likely	2,010	92.8	596	95.2	496	93.8	440	94.2	393	91.8	
Neutral/unlikely/very unlikely	156	7.2	30	4.8	33	6.2	27	5.8	35	8.2	

Knowledge level	Round 1 (N = 2,478)		Round 2 (N = 644)		Round 3 (N = 542)		Round 4 (N = 484)		Round 5 (N = 441)		p (trend)
	n	%	n	%	n	%	n	%	n	%	
Talk to a symptomatic infected person without physical contact											0.70
Very likely/likely	2,085	96.3	613	97.9	506	95.7	455	97.4	412	96.3	
Neutral/unlikely/very unlikely	81	3.7	13	2.1	23	4.3	12	2.6	16	3.7	
Physical touch with infected but asymptomatic persons											0.14
Very likely/likely	2,057	95.0	611	97.6	511	96.6	453	97.0	410	95.8	
Neutral/unlikely/very unlikely	109	5.0	15	2.4	18	3.4	14	3.0	18	4.2	
Physical touch with infected and symptomatic persons											0.03
Very likely/likely	2,084	96.2	615	98.2	519	98.1	458	98.1	418	97.7	
Neutral/unlikely/very unlikely	82	3.8	11	1.8	10	1.9	9	1.9	10	2.3	
Droplets											0.45
Very likely/likely	2,134	98.5	620	99.0	517	97.7	460	98.5	420	98.1	
Neutral/unlikely/very unlikely	32	1.5	6	1.0	12	2.3	7	1.5	8	1.9	
Aerosol when infected persons cough or sneeze											0.01
Very likely/likely	1,920	88.6	556	88.8	483	91.3	440	94.2	389	90.9	
Neutral/unlikely/very unlikely	246	11.4	70	11.2	46	8.7	27	5.8	39	9.1	
Virus-contaminated environment											0.86
Very likely/likely	2,064	95.3	598	95.5	499	94.3	445	95.3	410	95.8	
Neutral/unlikely/very unlikely	102	4.7	28	4.5	30	5.7	22	4.7	18	4.2	
Eating game (wild animals)											0.00
Very likely/likely	2,006	92.6	540	86.3	468	88.5	363	77.7	314	73.4	
Neutral/unlikely/very unlikely	160	7.4	86	13.7	61	11.5	104	22.3	114	26.6	
Wet market											0.00
Very likely/likely	1,750	80.8	422	67.4	366	69.2	356	76.2	311	72.7	
Neutral/unlikely/very unlikely	416	19.2	204	32.6	163	30.8	111	23.8	117	27.3	
Eating seafood imported from Wuhan											0.00
Very likely/likely	1,569	72.4	381	60.9	305	57.7	274	58.7	236	55.1	
Neutral/unlikely/very unlikely	597	27.6	245	39.1	224	42.3	193	41.3	192	44.9	
Eating/using other products imported from Wuhan											0.00
Very likely/likely	1,441	66.5	352	56.2	265	50.1	264	56.5	219	51.2	
Neutral/unlikely/very unlikely	725	33.5	274	43.8	264	49.9	203	43.5	209	48.8	