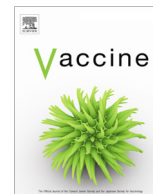




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Why do Hong Kong parents have low intention to vaccinate their children against COVID-19? testing health belief model and theory of planned behavior in a large-scale survey



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ABSTRACT

COVID-19 vaccines have been authorized for use in children in some societies. Parents' intention to vaccinate their children is context-specific. Drawing upon health belief model (HBM) and theory of planned behavior (TPB), this study contributed to a timely topic by examining the extent to which parents intended to vaccinate their children and its associated factors in Hong Kong, where the government announced children as young as five could take COVID-19 vaccines starting from 21 January 2022. A large-scale, online survey was conducted among 11,141 Hong Kong parents (86% mothers) of children aged 5–12 ($N = 14,468$, 49.5% girls). They reported on measures that assessed HBM constructs (i.e., perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action), TPB constructs (i.e., attitudes, subjective norms, and perceived behavioral control), and their intention to vaccinate each of their children. Results of descriptive statistics showed that Hong Kong parents' intention to vaccinate their children was very low (1.55 out of 5.00). Multilevel regression showed that after controlling for parents' and children's demographic variables (e.g., sex and age), parents' intention to vaccinate their children was higher if parents had higher levels of perceived susceptibility, perceived benefits, positive attitudes, and subjective norms and if they had lower levels of perceived barriers. Positive attitudes were the strongest correlate of parents' intention. These findings have important implications for public health by informing which factors authorities should address in order to boost Hong Kong parents' intention to vaccinate their children.

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1. Introduction

Receiving vaccination is a primary strategy to mitigate the impact of COVID-19. Children under 14 consist of about 25% of the global population [35] and boys and girls of this age have respectively contributed to about 10.7% and 10% of the total COVID-19 cases as of 1 January 2022 [36]. To have children vaccinated is a crucial step toward a more complete herd immunity against COVID-19 [41]. Parents' intention to let their children take COVID-19 vaccines is one of the most important factors that affect how much children would be covered in the COVID-19 vaccines campaign. However, a meta-analysis found that only about 56.8% parents intend to vaccinate their children and this rate varies greatly across societies [17].

The Hong Kong government officially announced that children as young as five could take COVID-19 vaccines starting from 21 January 2022 [34]. The announcement triggered fierce debates among parents. A preliminary study conducted in early 2021 based on a small sample of Hong Kong parents ($N = 349$) found that only 21.2% of parents would vaccinate their primary school children if COVID-19 vaccines were officially authorized for use in children [23]). This rate ranks almost the lowest among the existing findings from Australia [15]), Brazil [5], Canada [22], Japan [39], Latin America and the Caribbean [37], mainland China [16,40], Poland [4], and the US [32,33].

Although COVID-19 vaccines have been provided to young children in Hong Kong recently, no large-scale research has examined Hong Kong parents' concurrent intention to vaccinate their children against COVID-19 and its correlates. Without such knowledge, government may waste resources of public health if parents have very low intention to vaccinate their children on one hand; parents may lose trust in the government if the government advances the vaccines campaign persistently without hear-

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ing parents' voices on the other hand. In this study, we conducted a timely, large-scale survey from 11,141 parents of children aged 5–12 to examine the extent to which Hong Kong parents intend to arrange their children to receive COVID-19 vaccines and potential correlates from the perspectives of Health Belief Model (HBM) and Theory of Planned Behavior (TPB).

1.1. Overview of the COVID-19 pandemic and vaccination program in Hong Kong

The first case of COVID-19 in Hong Kong was reported on 21 January 2020. Hong Kong had experienced four waves of the pandemic by the end of 2021 and was facing the resurgence of the fifth wave of outbreak during this study. As of 1 March 2022, the five waves of outbreak have accumulated over 230,000 confirmed cases with nearly 1000 deaths in total [8]. Among the five waves of outbreak, the fifth resurgence is the biggest one with >210,000 cases and about 800 deaths between the beginning of January and the end of February 2022 [28]. It has resulted in heavy demand to the health-care system, suspension of face-to-face classes for students, closure of certain indoor shops and facilities (e.g., bars, gyms and beauty salons), and other strict social distancing policies.

The Hong Kong government announced that adults aged 18 years or above and young people aged 12 to 17 could receive free COVID-19 vaccines in February and June 2021, respectively. Two types of vaccines, namely CoronaVac (also known as Sinovac) and Pfizer-BioNTech, are available in community vaccination centers, public, and private clinics. The common side effects of vaccines that happen on receivers include pain and swelling of the injection site, tiredness, headache, muscle and joint pain, diarrhea, fever, nausea and vomiting. Some may experience side effects that are relatively uncommon, such as enlarged lymph nodes, allergic reactions, temporary one sided facial drooping, myocarditis or pericarditis (The Government of Hong Kong Special Administrative Region, 2022). Recently, the Hong Kong government announced that children as young as five could take CoronaVac starting from 21 January 2022 or Pfizer-BioNTech starting from 16 February 2022.

1.2. Parents' intention to vaccinate children from the perspectives of HBM and TPB

In this study, parents' intention to vaccinate their children was defined as the extent to which parents plan to arrange their children to receive COVID-19 vaccine, and it can be regarded as an intention to engage in a particular health behavior. HBM is an important theoretical framework to predict an individual's preventive health behavior (e.g., getting vaccines) in terms of a number of beliefs, including perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action [30]. The HBM postulates that an individual is more likely to adopt a particular health behavior if the individual is susceptible to health risk (i.e., high susceptibility), believes that the health risk would induce severe consequences (i.e., high severity), believes that taking that particular health behavior would be beneficial in reducing the susceptibility to or severity of the health risk (i.e., high benefits), believes that the cost of taking that health behavior is low (i.e., low barriers), and is triggered by internal or external cues to take actions (i.e., cues to actions; [10]. The HBM constructs have been extensively used to predict people's intention to take influenza vaccines (for reviews, see [6,7]. In the context of parents' intention to arrange their children to take COVID-19 vaccines, *perceived susceptibility* refers to parents' general perception about children's vulnerability to COVID-19, such as whether children are more or less likely to be infected. *Perceived severity* refers to parents' general perception about the negative

effects if children contract COVID-19, such as whether children have more or fewer severe symptoms if they are infected. *Perceived benefits* refer to parents' general perception of the benefits if children take the vaccines, such as preventing children's own and their families' health. *Perceived barriers* refer to parents' general perception of the negative consequences if children take the vaccines, such as the side effects of vaccines. *Cues to action* refers to the internal or external triggers that motivate parents to vaccinate children, such as the situation of pandemic in Hong Kong is severe. Prior studies have found that HBM constructs were related to the intention to take COVID-19 vaccines in adults [13,21,25,31]. However, we have located only one study that used HBM constructs to predict parents' intention to vaccinate their children in US (Zakeri et al., 2021). It found that parents who intended to vaccinate their children perceived higher levels of susceptibility, severity, benefits, and stronger cues and lower levels of barriers than those who did not intend to.

TPB is another important model that explains an individual's health behavior, and it has been proposed to be important for explaining parents' behavioral patterns in protecting their children from COVID-19 [12]). It is proposed in the TPB that an individual's *intention* to engage in a particular behavior is the most powerful predictor of that behavior and that behavioral intention is determined by three core constructs, namely attitudes, subjective norms, and perceived behavioral control [1]. These three constructs are well defined in Ajzen's [3] study. *Attitudes* are the overall product by the positive or negative valence of each anticipated outcome or experience of the behavior. Subjective norms consist of *injunctive* and *descriptive* normative beliefs. The former is defined as a given referent individual or group approves or disapproves of performing a certain behavior, and the latter is defined as beliefs of whether important others themselves would perform the behavior. *Perceived behavior control* can be defined as the sum product of an individual's control belief and power over all the factors that facilitate or impede performance of the behavior of interest. Based on these constructs, it is posited in the TPB that an individual would likely form a stronger intention to engage in a particular behavior if he/she has positive attitudes toward that behavior, perceives strong subjective norms, and believes he/she has the capability to carry out that behavior, and that the individual will be more likely engender that specific action with a stronger intention [1,3]. Some studies have used TPB to explain adults' intention to receive COVID-19 vaccines, findings that positive attitudes toward taking vaccines (e.g., believe taking vaccines is wise), stronger subjective norms (e.g., significant others also take vaccines), and high perceived behavioral control (e.g., have the autonomy to make the decision) are positively related to stronger intention to receive vaccines [13,21,31]. So far, we have located only one paper that used TPB to examine parents' intention to vaccinate their children in mainland China [40]. It found that parents who had positive attitudes, strong subjective norms, and high perceived behavior control reported more likelihood to have their children vaccinated.

Taken together, HBM and TPB are important theoretical frameworks to explain an individual's intention to receive COVID-19 vaccines. However, very few studies have used them to examine parents' intention to vaccinate their children, especially in the Hong Kong context. Moreover, among the limited studies (e.g., Zakeri et al., 2021; [40], none of them considered using multilevel analysis to examine their data, although the data were nested in nature (i.e., children nested in families/parents). As mentioned above, Hong Kong parents seemed to be much less keen to have their children vaccinated compared to parents in other countries. Using sophisticated analysis to understand Hong Kong parents' intention and its correlates would inform the government and related practitioners about how to address parents' concerns and boost their intention.

1.3. Demographic factors associated with Parents' intention to vaccinate children

Although few studies have examined the role of HBM and TPB constructs in parents' intention to vaccinate their children against COVID-19, the existing studies have extensively tested the effects of parents' (e.g., sex, age, educational levels, family income, and history of COVID-19 vaccines) and children's (e.g., sex, age, and history of influenza vaccines) demographics on parents' intention (e.g., [5,19;22;32;41]). Many of the findings suggest that parents more intend to vaccinate their children if parents are older, come from higher socioeconomic families (e.g., higher educational attainment and earn more), and have taken COVID-19 vaccines themselves and if children are older and physically appropriate for influenza vaccines. In light of these findings, we will also control for a range of demographic variables to obtain a more robust findings for the associations between HBM and TPB constructs and parents' intention.

1.4. The current study

Based on HBM and TPB, the aim of this study was to understand Hong Kong parents' intention to arrange their children to take COVID-19 vaccines and its correlates. To this end, we examined two questions: (1) to what extent parents would arrange their children to take COVID-19 vaccines, and (2) to what extent HBM constructs (i.e., perceived susceptibility, severity, benefits, barriers, and cues to action) and TPB constructs (i.e., attitudes, subjective norms, and perceived behavioral control) would be associated with parents' intention, after controlling for the demographic variables. These questions are incorporated into a single model as illustrated in Fig. 1. Based on prior studies, we hypothesize that Hong Kong parents would report low intention to vaccinate their children. Further, we hypothesized that higher levels of perceived susceptibility, severity, benefits, cues to actions, positive attitudes, subjective norms, and perceived behavioral control would be positively related to parents' intention while higher levels of perceived barriers would be negatively associated with parents' intention.

2. Method

2.1. Participants and procedure

Participants of this study were recruited using two sampling strategies. First, a total population sampling strategy was utilized, in which invitation emails were sent to all kindergartens (>1000) and primary schools (>500) in Hong Kong explaining the aim of the study. Schools were invited to share the invitation letter with parents. Parents who were interested to participate were invited to complete the consent form and survey through the link included in the invitation letter. Second, the study recruited a convenience sample via a Facebook page managed by the unit the authors are affiliated with. While the selection process based on voluntary acceptance may lead to important bias, the recruitment strategy utilized was considered necessary to ensure that a large number of participants would respond to our study during school suspension. The Data from the participants who met the following exclusion criteria were omitted from the study analysis: 1) participants who were guardians of children other than mothers or fathers, and 2) children who were not studying in kindergartens or primary schools in Hong Kong.

The final sample were 11,141 parents (86% mothers) of 14,468 kindergarten and primary school children (49.5% girls). On average, participating parents had 1.30 children aged 5–12 years. Detailed demographic information is summarized in Table 1. The current sample is considered mostly a middle-class sample [9]. The online anonymous survey was administered during 20 to 27 January 2022. The participating parents filled out an online survey (Qualtrics) through an anonymous hyperlink posted in the Facebook fan page or on the invitation distributed by the school. Prior approval by the Human Research Ethics Committee at the authors' university was obtained.

2.2. Measures

The online survey contained three parts. Specifically, part I pertained to the outcome measure targeted at each child within the family; part II was about parents' perceptions and beliefs of the

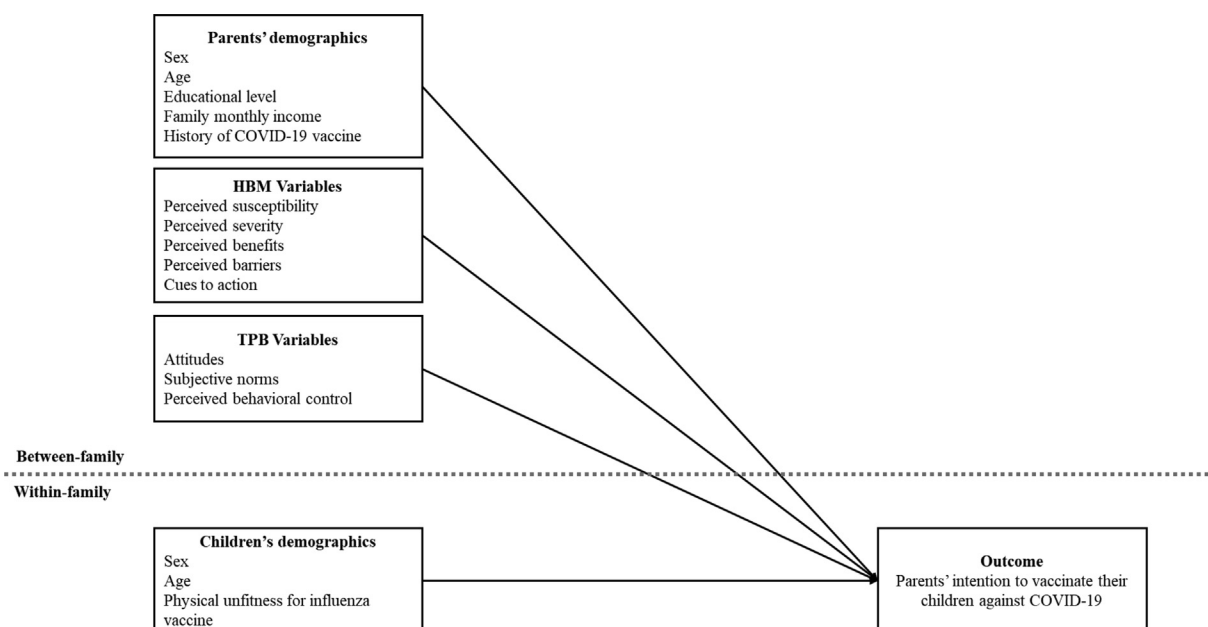


Fig. 1. Conceptual Illustration for the Multilevel Associations between HBM and TPB Constructs and Parents' Intention to Vaccinate Their Children Controlling for Parents' and Children's Demographics.

Table 1
Summary of Parents' and Children's Demographic Information.

Demographic information	N (%)
Parents' demographics	
Sex	
Female (Mother)	9,576 (86.0%)
Male (Father)	1,565 (14.0%)
Age	
30 years old or below	541 (4.8%)
31 – 40 years old	6,763 (60.7%)
41 – 50 years old	3,707 (33.3%)
> 50 years old	130 (1.2%)
Number of children in household	
1	7,882 (70.7%)
2	3,063 (27.5%)
3 or above	196 (1.8%)
Educational Level	
Middle school or below	3,363 (30.2%)
Diploma/associate bachelor	2,305 (20.7%)
Bachelor or above	5,473 (49.1%)
Family monthly income (US\$1 = HK\$7.78)	
HK\$20,000 or below	1,523 (13.7%)
HK\$20,001 – HK\$40,000	3,168 (28.4%)
HK\$40,001 – HK\$60,000	2,678 (24.0%)
HK\$60,001 – HK\$80,000	1,532 (13.8%)
HK\$80,001 – HK\$100,000	942 (8.5%)
> HK\$100,000	1,298 (11.7%)
History of COVID-19 vaccines	
Not vaccinated	3,206 (28.8%)
At least vaccinated one dose	7,935 (71.2%)
Total N of parents	11,141
Children's demographics	
Sex	
Boys	7,311 (50.5%)
Girls	7,157 (49.5%)
Age	
5	4,311 (29.8%)
6	2,819 (19.5%)
7	2,467 (17.1%)
8	1,636 (11.3%)
9	1,351 (9.3%)
10	1,059 (7.3%)
11	705 (4.9%)
12	120 (0.8%)
M ± SD	6.97 (1.88)
School year	
Kindergarten	4,832 (33.4%)
Lower elementary school (P1 – P3)	6,764 (46.8%)
Upper elementary school (P4 – p6)	2,872 (19.8%)
Physically unfit for influenza vaccines (M ± SD)	2.56 (1.31)
Total N of children	14,468

HBM and TPB constructs in general; and part III was about demographic backgrounds of parents and children. As described in full below, these variables were assessed with validated measures used in prior studies and self-devised items developed according to the theoretical models and based on previous studies on psychosocial influence on people's perception on influenza vaccination for young children in Hong Kong and international contexts [13,20;24]. All the measures were consistent with the definitions given above. A total of 20 parents were invited to complete a pilot survey and suggestions were provided by them to enhance the clarity of items. Minor changes to the wording in Chinese were made before the survey was launched. Parents were asked to complete the questionnaire for their family once. All items are displayed in Table 2.

2.3. Outcome measure

Parents' intention to vaccinate their children against COVID-19 was measured with a single item "Without any policy restrictions, I will arrange this child to take COVID-19 vaccines" on a five-point

Likert scale (from "1 = strongly disagree" to "5 = strongly agree"). This item was constructed on the basis of a recent study about parents' intention to take their children for COVID-19 vaccination in Hong Kong[23]. In this item parents were asked to report their intention toward each of their children aged 5–12 if they had more than one child within this age range. A higher score indicated a stronger intention.

2.4. HBM constructs

Four HBM constructs, namely *perceived susceptibility*, *perceived severity*, *perceived barriers*, and *cues to actions*, were each measured using a single self-devised item with high face validity. On the other hand, five items were developed to assess the multidimensional nature of "perceived benefits of vaccinating children" (see Table 2). All items were rated on a 5-point Likert scale (from "1 = strongly disagree" to "5 = strongly agree"). The five items of "perceived benefits" were averaged and the mean score was used as an indicator of the overall benefits of vaccinating children perceived by parents. A higher score indicated higher levels of perceived susceptibility, perceived severity, perceived barriers, perceived barriers, and cues to actions.

2.5. TPB constructs

Attitudes. Parents' attitudes toward children receiving COVID-19 vaccination was measured using six items, four of them adapted from the items used in Chu & Liu's [13] study for assessing people's attitudes toward receiving the COVID-19 vaccines and the remaining two items were self-devised. Participants were asked to choose the feeling that best describes him/herself regarding his/her children receiving COVID-19 vaccines in the future on a 5-point scale (i.e., from "1 = Negative to 5 = Positive", "1 = Unfavorable to 5 = Favorable", "1 = Bad to 5 = Good", "1 = Unsafe to 5 = Safe", "1 = Harmful to 5 = Beneficial" and "1 = Foolish to 5 = Wise"). A higher mean score indicated more positive attitudes of parents.

Subjective Norms. Parents' perception of subjective norms was measured using three items adapted from the items used in Chu & Liu's [13] study. The original items were developed for assessing subjective norms related to adults' intention to get COVID-19 vaccines. In this study, participants rated whether they agree with the statements of descriptive and injunctive norms related to vaccinating their children against COVID-19 using a 5-point Likert scale (from 1 = "strongly disagree" to 5 = "strongly agree"; e.g., "Most parents like me will arrange their children to take COVID-19 vaccines"). A higher mean score indicated stronger subjective norms.

Perceived Behavioral Control. Parents' perception of their ability to control the process of vaccinating their children was measured with two items used in Chu & Liu's [13] study. The original items operationalized perceived behavioral control as self-efficacy due to their similarities, thus measuring how much adults perceived that they were capable of executing the behavior of receiving COVID-19 vaccines. In this study, we measured parents' perception of how much they felt easy to and they would manage to vaccinate their children using a 5-point Likert scale (from 1 = "strongly disagree" to 5 = "strongly agree"). A higher mean score indicated higher levels of perceived behavioral control.

2.6. Statistical analysis

To answer the first question, we conducted descriptive statistics (means and standard deviation, SD) in SPSS 27.0 to capture the central tendencies of Hong Kong parents' overall intention to vaccinate their children. To answer the second question, we first conducted Pearson's bivariate correlations in SPSS to examine pairwise correlations between HBM and TPB constructs and parents'

Table 2
Items to Measure the Main Study Variables.

Items
HBM constructs
Perceived susceptibility Children have lower chance of being infected with COVID-19 (reversed score)
Perceived severity If children are infected with COVID-19, the symptoms will be more severe than adults
Perceived benefits (Cronbach's $\alpha = 0.88$) Children receiving COVID-19 vaccines can prevent children from getting infected by COVID-19 Children receiving COVID-19 vaccines can reduce the severity of the symptoms in case children are infected with COVID-19 Children receiving COVID-19 vaccines can effectively prevent family members from infecting with COVID-19 Children receiving COVID-19 vaccines can effectively prevent the spread of Coronavirus in the community Children who received COVID-19 vaccines can prevent them from infecting with COVID-19 in school
Perceived barriers I am concerned about the possible side effects of children receiving COVID-19 vaccines
Cues to action The current COVID-19 pandemic in Hong Kong is severe
TPB constructs
Attitudes (my attitude toward my children receiving COVID-19 vaccines in the future is ...) (Cronbach's $\alpha = 0.98$) Negative.....Positive Unfavorable.....Favorable Bad.....Good Unsafe.....Safe Harmful.....Beneficial Foolish.....Wise
Subjective norms (Cronbach's $\alpha = 0.89$) Most parents like me will arrange their children to take COVID-19 vaccines Most parents of my children's classmates would arrange their children to take COVID-19 vaccines Important people around me suggest that I should arrange my children to take COVID-19 vaccines
Perceived behavioral control (Cronbach's $\alpha = 0.80$) For me, it is easy to arrange my children to receive COVID-19 vaccines If I plan to arrange my children for receiving COVID-19 vaccines, I am confident that my children will be vaccinated successfully
Outcome Without any policy restrictions, I will arrange this child to take COVID-19 vaccines

intention. Given the large sample size, we also used Cohen's (1992) standards to evaluate the effect sizes of the correlations, with 0.10, 0.30, & 0.50 representing small, medium, and large effect, respectively. We then performed regression analysis to further examine the focal associations in Mplus 8.3, controlling for the demographic variables of parents and children. Since some variables were skewed (i.e., skewness > 2), the maximum likelihood estimation with robust standard errors (MLR) was used as this approach is robust to non-normality[26]. Since the data was nested in nature (i.e., children nested in families/parents), we examined the intra-class correlation (ICC) of parents' intention by fitting an intercept-only model. The results showed that within-family variances were 0.048 and between-family variances were 1.155, yielding a high ICC (i.e., $1.155/(0.048 + 1.155) = 0.96$). This suggested that multilevel modeling would be needed. Following Enders and Tofighi's[14] guideline, we centered covariates at the within-family level (i.e., children's demographic variables) with a group mean function, whereas we centered covariates (i.e., parents' demographic variables) and correlates (i.e., the HBM and TPB constructs) at the between-family level with a grand mean function. As the main questions of this study were to examine the associations between HBM and TPB constructs and parents' intention, a random intercept, fixed slope model was applied.

3. Results

As shown in Table 3, results of descriptive analyses showed that Hong Kong parents reported very low levels of intention to vaccinate their children ($M = 1.55$, $SD = 1.11$). In addition, results of bivariate correlations found that except for the negative association between perceived barriers and parents' intention, the remaining four HBM constructs were positively related to parents' intention, with the effect sizes ranging from small-to-medium to close-to-high. Besides, TPB constructs were all positively related

to parents' intention, with the effect sizes ranging from medium to large. Among all the main constructs, positive attitudes toward children taking vaccines showed a particular strong effect ($r > 0.80$).

The results of multilevel regression model are summarized in Table 4. At the within-family level, parents' intention to vaccinate a specific child was stronger if the child was older. In addition, the residual variance at the within-family level was 0.048, which was the same as the within-family variance found in the intercept-only model as mentioned above. This suggested the within-family level covariates explained (nearly) no variance of parents' intention within families.

At the between-family level, parents' intention was stronger if parents had received at least one dose of COVID-19 vaccines themselves. Regarding the role of HBM constructs, parents had a stronger intention to arrange their children to receive COVID-19 vaccines when they were more prone to believe that children were susceptible to COVID-19 (i.e., high levels of perceived susceptibility), that children receiving vaccines would be beneficial (i.e., high levels of perceived benefits), and that there would be few concerns for the side effects (i.e., low levels of perceived barriers). Regarding the role of TPB constructs, parents' intention was stronger if they had higher levels of positive attitudes toward vaccinating their children and if they reported stronger subjective norms. The residual variance at the between-family level was 0.301, suggesting that the covariates and correlates included in this level explained $(1.155 - 0.301)/1.155 = 73.9\%$ variance of parents' intention.

Taken together, these findings suggested that Hong Kong parents' intention to vaccinate their children was very low. Moreover, parents' intention was related to part of the HBM (i.e., perceived susceptibility, perceived benefits, and perceived barriers) and TPB (i.e., attitudes and subjective norms) constructs, after controlling for a range of demographic variables of parents and children.

Table 3
Means, Standard Deviations, and Bivariate Correlations of the Main Study Variables.

	1	2	3	4	5	6	7	8	9
HBM constructs									
1. Perceived susceptibility	–								
2. Perceived severity	-0.04**	–							
3. Perceived benefits	0.07**	0.34**	–						
4. Perceived barriers	-0.16**	0.01	-0.10**	–					
5. Cues to action	-0.05**	0.38**	0.21**	-0.03**	–				
TPB constructs									
6. Attitudes	0.25**	0.25**	0.54**	-0.24**	0.17**	–			
7. Subjective norms	0.13**	0.26**	0.52**	-0.14**	0.18**	0.67**	–		
8. Perceived behavioral control	0.06**	0.19**	0.43**	-0.07**	0.12**	0.41**	0.44**	–	
Outcome									
9. Parents' intention	0.24**	0.22**	0.48**	-0.22**	0.15**	0.84**	0.63**	0.36**	–
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
M	2.30	2.96	2.23	3.80	3.04	1.69	1.87	2.39	1.55
SD	1.48	1.62	1.22	0.71	1.39	1.07	1.24	1.42	1.11
Skewness	0.57	0.17	0.66	-2.26	0.12	1.74	1.37	0.53	2.00

Note: ** $p < .001$.

Table 4
Multilevel Regression Model of Parents' Intention to Vaccinate Children on HBM and TPB Constructs.

	B	SE	p	β
Within-family level covariates				
Child sex (1 = boy; 2 = girl)	-0.01	0.01	-0.256	-0.01
Child age	0.01	0.00	< 0.001	0.06
Child physical unfit for influenza vaccines	-0.01	0.01	0.497	-0.01
Between-family level covariates and predictors				
Parent sex (1 = mother; 2 = father)	0.03	0.02	0.103	0.01
Parent age (30 years old or below as reference)				
31 – 40 years old	-0.01	0.03	0.829	-0.00
41 – 50 years old	-0.01	0.03	0.786	-0.00
> 50 years old	0.08	0.07	0.285	0.01
Parent educational level (middle school or below as reference)				
Diploma/associate bachelor	0.03	0.02	0.065	0.01
Bachelor or above	0.03	0.02	0.107	0.01
Family monthly income (HK\$20,000 or below as reference)				
HK\$20,001 – HK\$40,000	-0.02	0.02	0.300	-0.01
HK\$40,001 – HK\$60,000	-0.02	0.02	0.475	-0.01
HK\$60,001 – HK\$80,000	-0.02	0.02	0.322	-0.01
HK\$80,001 – HK\$100,000	-0.04	0.03	0.130	-0.01
> HK\$100,000	-0.00	0.03	0.947	0.00
Parent history of COVID-19 vaccines (1 = no; 2 = at least one dose)	0.04	0.01	< 0.001	0.02
HBM constructs				
Perceived susceptibility	0.03	0.00	< 0.001	0.04
Perceived severity	-0.00	0.00	0.763	-0.00
Perceived benefits	0.02	0.01	0.005	0.02
Perceived barriers	-0.03	0.01	0.001	-0.02
Cues to action	0.08	0.00	0.064	0.01
TPB constructs				
Attitudes	0.76	0.01	< 0.001	0.75
Subjective norms	0.10	0.01	< 0.001	0.11
Perceived behavioral control	-0.00	0.00	0.596	-0.00
Within-family level residual variance	0.048	0.007	< 0.001	0.997
Between-family residual variance	0.301	0.012	< 0.001	0.261

Significant findings are bolded.

4. Discussion

Taking COVID-19 vaccines is one of the most important strategies to mitigate the impacts of the pandemic. COVID-19 vaccines have been available for adults for more than one and a half years, but its use among children, especially young children under 12, has been only approved in some societies in recent months. In Hong Kong, the government announced that young children could receive COVID-19 vaccines starting from 21 January 2022[34]. This study found that Hong Kong parents had *very low intention* to

arrange their children to receive vaccines. Moreover, we also found that perceived severity, perceived benefits, positive attitudes, strong subjective norms were related to stronger intention while perceived barriers were related to weaker intention.

The low levels of intention were in contrast to the findings from other countries [4,5;15,16,22,32;33;40,37,40] but consistent with an earlier, smaller-scale study conducted in Hong Kong parents [23]. We speculate that possible reasons to explain this low intention could be due to insufficient scientific information about the safety and efficacy of the COVID-19 vaccines in children, percep-

tion of relatively low severity of the pandemic in Hong Kong compared to other societies, possession of the belief that symptoms are not severe in children even if they are infected compared to adults, and low willingness to risk their children's lives for receiving the vaccines because of the potential side effects. These reasons are consistent with the concerns of parents in other societies, although experts have pointed out that many of the aforementioned beliefs are biased and that children do play an increasingly important role in transmitting COVID-19 especially after variants of the coronavirus emerge [18,38]. Despite the current low intention, it deserves attention that it also took a while for adults to accept and receive the vaccines at the beginning when COVID-19 vaccines were available, but the rate of vaccination boosted greatly in many countries a few months later as more scientific information had been provided [27]. For the current sample, although most parents did not intend to arrange their children to take COVID-19 vaccines at the moment, parents' intention might change after they learn more about the vaccines, especially during the current fifth resurgence of outbreak.

Many studies have identified a number of parents' (e.g., sex, age, educational levels, family income, and history of COVID-19 vaccines) and children's (e.g., sex, age, and history of influenza vaccines) demographic variables that are significantly associated with parents' intention to vaccinate their children (e.g., [5,19;22;32;41]). Unlike those studies, the present research found that only two demographic variables (i.e., child age and parents' history of receiving COVID-19 vaccines themselves) were significantly related to parents' intention after taking into account other important correlates (e.g., personal beliefs and perceptions). This may suggest that the two demographic factors identified in this study appear particularly robust in associating with parents' intention to vaccinate their children. On the other hand, including other psychosocial correlates may nullify the (potential) effects of demographic backgrounds suggest that psychosocial correlates (e.g., HBM and TPB constructs) may serve as mediators between demographic variables and parents' intention. Of note, some demographic variables, such as whether the child had received influenza vaccines, occupation of parents, and sources of information about COVID-19 vaccine, have been found to be related to parents' intention (e.g., [19,39]), but these variables were not controlled for in this study. The main reason was that including these measures would substantially increase the length of our survey, which might lead to issues of the response burden and other methodological concerns that might be heightened in an extended survey [11]. In our large scale survey, we aimed to keep our survey at an optimal length to avoid exhausting participants' attention at the end of the survey. Nevertheless, the items used in this study can be seen as the approximates of the missing variables. For instance, we used parent educational level and family monthly income to represent family socioeconomic status in lieu of parent occupation.

Going above and beyond most existing studies, this research also examined the role of HBM and TPB constructs in parents' intention. Some HBM (i.e., perceived susceptibility, perceived benefits, and perceived barriers) and TPB (i.e., positive attitudes and subjective norms) constructs were significantly related to parents' intention to vaccinate their children against COVID-19. Among the significant correlates, parents' positive attitudes were the strongest factor associated with parents' intention to vaccinate their children, followed by the subjective norms. The magnitudes of the regression coefficients of the HBM variables were much smaller ($\beta < 0.10$). These findings suggested that the TPB appeared to explain parents' intention better than the HBM. This result is consistent with a prior study which also found that the TPB outperformed HBM in accounting for adults' intention to receive COVID-19 [21]. Prior studies based either on HBM or on TPB found

that the HBM (Zakeri et al., 2021) or TPB [40] variables were all significantly related to parents' intention. However, studies that used both models to examine adults' intention to take COVID-19 vaccines found that not all the HBM and TPB constructs had significant effects, with some variables showing significant effects in one study and other variables showing significant effects in another study [13,21,31]. A possible explanation for the inconsistent findings could be because the factors that explain parents' intention to vaccinate their children is context-specific. Our current data only reflected the situation in Hong Kong and it is unsurprising that these findings were different from the ones found in other societies. As very few studies have examined factors associated with parents' intention to vaccinate their children using HBM and TPB constructs simultaneously, more studies using both models to revisit this topic are highly encouraged. For instance, it is promising for future research to examine the extent to which the HBM (TPB) constructs would mediate the associations between demographic variables and TPB (HBM) constructs and parents' intention to vaccinate their children.

Because the participating Hong Kong parents' intention to vaccinate their children is low and their intention is related to a range of HBM and TPB variables, our findings provide important implications to public health. Considering the critical role of children in transmitting the coronavirus, the low priority for vaccination among children, the negative physical and psychosocial consequences of contracting COVID-19, and the safety and efficacy of vaccines, scholars have been promoting children to receive COVID-19 vaccines to reduce community transmission and mortality and to boost herd immunity [18,38]. The current study identified the factors that were associated with parents' intention to vaccinate their children, informing that these factors could be targeted to increase parents' intention. That being said, we consider that whether to arrange children to receive COVID-19 vaccine should be at parents' discretion. Efforts by policy makers and healthcare providers are necessary to provide active public education related to the efficacy and safety of vaccinating children against COVID-19 to parents living in Hong Kong. With transparent information about the safety profile of COVID-19 vaccines for (young) children based on scientific evidence, parents will be well-informed for making a timely decision for whether to vaccinate their children.

5. Limitations

This study has some limitations we must acknowledge. First, as the sampling method relied on voluntary responses from parents, there are potential response bias where parents with stronger attitudes toward children receiving COVID-19 vaccines might be more prone to respond to the survey. Second, the sample consisted of much more mothers than fathers. Although the number of fathers was large itself, a more balanced number of sample size would make the findings more compelling. Third, the cross-sectional design only captured a snapshot of parents' intention to vaccinate their children, but it did not inform how parents' intention would change over time. As mentioned above, parents' intention to arrange their children to receive COVID-19 vaccines may change as the pandemic evolves and more information about the vaccines is released. Given this, it is promising for future research to monitor and model the changes in parents' intention, and the reader should keep a dynamic perspective in mind when interpreting the current findings. Fourth, similar to prior studies [13,21,31], Zakeri et al., 2021; [40], this study only measured intention but not actual behavior. Although the "intention – behavior" gap is not uncommon, meta-analyses have revealed substantial effect size for the association between intention and actual behavior [2,29].

This suggests that measuring parents' intention to vaccinate their children would be an important step to estimate their actual behavior of arranging their children to receive vaccines in the future. Given this, it is promising for future studies to use longitudinal design to examine the association between parents' intention and their actual arrangement. Specifically, it would be crucial to investigate the extent to which the changes in HBM and TPB variables would predict whether parents would *actually* have their children vaccinated.

6. Conclusion

Parents' intention is a crucial factor related to how much children will be covered in the COVID-19 vaccines campaign, and such intention is context-specific. This study is the among the first to use a large-scale survey and sophisticated statistical approaches to reveal the extent to which Hong Kong parents intend to arrange their children to receive COVID-19 vaccines and its correlates. The findings suggest that Hong Kong parents' concurrent intention to vaccinate their children against COVID-19 is *very low*. Parents' intention would be higher when they believe that children are susceptible to COVID-19, that there are benefits if children receive vaccines, that the side effects of vaccines are not concerning, that parents have positive attitudes toward their children getting vaccinated, and that parents perceive strong subjective norms. These findings inform key points that the government, policy makers, and public health practitioners should address in order to boost parents' intention to vaccinate their children against COVID-19.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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