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1 **Parental perceptions of childhood seasonal influenza vaccination in Singapore: A cross-**
2 **sectional survey**

3

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23 **Abstract**

24

25 *Purpose:*

26 Seasonal influenza vaccination is recommended in children aged 6-59 months, but little is known
27 about child vaccination coverage and determinants in Asian settings. We report the results of a
28 survey of knowledge, attitudes, practices, and determinants of child influenza vaccination in
29 Singapore.

30

31 *Methods:*

32 In December 2015-March 2016, we conducted a survey of 332 parents of children aged 6 months
33 to 5 years attending pre-schools. We assessed child influenza vaccine coverage and parental
34 knowledge, attitudes, and practices of child influenza vaccination. We used multivariable
35 regression and structural equation models to identify factors associated with child influenza
36 vaccination.

37

38 *Results:*

39 Knowledge about influenza, perceived benefit of vaccination, and willingness to vaccinate were
40 high. However, only 32% of children had ever received influenza vaccine, and only 15% in the
41 past year. Factors independently associated with child influenza vaccination included: being
42 recommended influenza vaccine by a child's doctor (prevalence ratio (PR)=2.47, 95% CI: 1.75-
43 3.48); receiving influenza vaccine information from a private general practitioner (PR=1.47, 95%
44 CI: 1.05-2.04); regularly receiving pre-travel influenza vaccine (PR=1.64, 95% CI: 1.19-2.25);
45 higher willingness to vaccinate (PR=1.58, 95% CI:1.24-2.04 per unit increase in willingness
46 score); and feeling well-informed about influenza vaccine (PR=1.44, 95% CI: 1.04-1.99). Parents

47 who obtained influenza vaccine information from television were less likely to have vaccinated
48 their child (PR=0.44, 95% CI: 0.23-0.85). Path analysis indicated that being recommended
49 vaccination by a child's doctor increased willingness to vaccinate and self-efficacy (feeling well-
50 informed about influenza vaccine). Median willingness-to-pay for a dose of influenza vaccine was
51 SGD30 (interquartile range: SGD20-SGD50), and was higher in parents of vaccinated compared
52 with unvaccinated children (SGD45 vs SGD30, p=0.0012).

53

54 *Conclusion:*

55 Knowledge and willingness to vaccinate was high in this parent population, but influenza vaccine
56 uptake in children was low. Encouraging medical professionals to recommend vaccination of
57 eligible children is key to improving uptake.

58

59 **Word count:** 299

60

61 **Keywords**

62 Influenza; influenza vaccine; child health; health survey; vaccination policy; vaccination coverage

63 **Introduction**

64

65 Influenza is a major cause of disease burden among children below 5 years of age, causing an
66 estimated 870,000 hospitalisations and 10,200 deaths per year worldwide [1,2]. Most influenza-
67 associated deaths occur in low-income countries, but there is a substantial disease burden in
68 high-income countries, where an estimated 55 cases of influenza, 15 cases of influenza-associated
69 lower respiratory infection, and 1 case of severe influenza infection occur per 1000 children
70 below 5 years of age [3].

71

72 Influenza vaccine effectiveness varies between countries and across influenza seasons, but
73 studies in Asia [4,5] and Europe [6,7] have shown good effectiveness of seasonal influenza
74 vaccine among young children. As parents are the main healthcare decision makers for their
75 young children, understanding parental perceptions towards influenza vaccination is important
76 for informing interventions to encourage uptake. A survey carried out in England found that
77 vaccine uptake was associated with parental perception that the influenza vaccine was effective
78 and their child was susceptible to influenza [8]. Conversely, in the National Flu Survey in the
79 United States, parents' perception that their child was not at risk for influenza or severe illness
80 from influenza was the most common reason for not vaccinating their child [9]. In both studies,
81 the perception that the vaccine was unsafe was associated with children not being vaccinated
82 [8,9]. Perceived safety was also found to be significantly associated with parents' acceptance of an
83 offer to vaccinate their child against influenza in a study carried out in Sydney, Australia [10].

84

85 Although several studies of parental perceptions regarding child influenza vaccination have been
86 published, most of these have been conducted in Western settings. Parental perceptions that

87 influenza uptake of child influenza vaccine are not well described in Asian settings, and no
88 previous studies have been conducted in Singapore, where influenza epidemiology [11],
89 vaccination policy and financing, healthcare structure, and patient-doctor dynamics are generally
90 very different from Western settings.

91
92 In Singapore, a high-income country in the tropics, influenza circulates year-round with two main
93 peaks in December and June coinciding with Northern and Southern Hemisphere epidemics.
94 Between 2010 and 2012, influenza-associated hospitalisations were estimated at approximately
95 96 per 100,000 person-years among children aged 6 to 23 months and 64 per 100,000 person-
96 years among children aged 2 to 4 years, corresponding to an excess in hospitalisations coded as
97 pneumonia and influenza of 13% and 9% respectively [12].

98
99 The Singapore Ministry of Health recommends annual vaccination of children aged 6-59 months
100 old with trivalent or quadrivalent inactivated influenza vaccine, but there is currently no
101 universal childhood influenza vaccination programme. Financing of childhood vaccines in
102 Singapore is complex and depends on the specific vaccine, residential status of the child, and
103 whether vaccines are administered in the public or private sector. Vaccines included in the
104 National Childhood Immunisation Schedule, such as those for tuberculosis (BCG); Hepatitis B;
105 Diphtheria, Tetanus, Pertussis (DTaP); Measles, Mumps, Rubella (MMR); Poliovirus (IPV); and
106 *Haemophilus influenza* type b (HiB), are available free of charge in the public sector for
107 Singaporeans and subsidised for Permanent Residents [13,14]. The cost of other recommended
108 vaccines that are not in the National Childhood Immunisation Schedule is not covered by the
109 public health sector. These include the influenza vaccine, pneumococcal vaccine, chicken pox
110 vaccine, and human papillomavirus vaccine. However, parents can choose to pay for their child's

111 influenza vaccine through a variety of ways: (i) their Medisave, a mandatory medical savings
112 account for Singaporeans and Permanent Residents, (ii) their child's Baby Bonus cash gift, a one-
113 time cash gift for children born on or after 1 January 2015, or (iii) savings in the Child
114 Development Account, a special savings account for which the government will match the amount
115 of savings for children born on or after 24 March 2016 [15,16]. In addition, influenza vaccine can
116 be purchased out-of-pocket in the private sector. Administration of influenza vaccine is not
117 universally documented on child electronic immunisation records, particularly for children
118 vaccinated in the private sector, so reliable data on child influenza vaccination coverage in
119 Singapore are lacking.

120

121 We conducted a cross-sectional survey to (i) estimate influenza vaccine coverage among children
122 aged 6 months to 5 years in Singapore, (ii) examine parental knowledge, attitudes, and practices
123 regarding child influenza and influenza vaccination, and (iii) investigate factors associated with
124 child influenza vaccination.

125 **Methods**

126

127 *Sample*

128

129 Between December 2015 and March 2016, we conducted a cross-sectional survey of parental
130 perceptions of child influenza vaccination in Singapore. The study was conducted by medical
131 students as part of a capstone community health project. We approached 102 pre-schools with
132 students aged 6 months to 5 years, selected at random from a list of institutions registered with
133 the Early Childhood Development Agency, a regulatory authority which oversees pre-schools in
134 Singapore. Of these, 17 agreed to disseminate information about the study to parents and a link to
135 an online survey. Due to time constraints, and because initial response was low, additional pre-
136 schools from the list were recruited through convenience sampling. Overall, a total of 325 pre-
137 schools were approached, of which 92 agreed to disseminate study information. 36 out of the 92
138 pre-schools also allowed the students to visit the pre-schools in pairs to recruit parents in person
139 and invite them to complete the online questionnaire on site or at their own convenience with a
140 link to the online survey for parents who did not have time to complete it at the child care centre.

141

142 Eligible parents were those with a child aged 5 years or below attending a pre-school included in
143 the study. A target sample size of 385 was pre-determined based on the ability to estimate an
144 influenza vaccine coverage of 50% +/- 5% with 95% precision.

145

146 *Questionnaire*

147

148 The anonymous, online survey questionnaire was developed using Qualtrics software (Qualtrics
149 Labs, Inc.) and could be completed on mobile devices. The questionnaire consisted of 81
150 questions, assessing factors which were found to be associated with child vaccinations in the
151 literature. These included cost of vaccine [17], place of vaccination [18], doctor's
152 recommendation [19,20], government guidelines [21], parents' influenza vaccination status [19],
153 and intention to travel [22]. Our survey questionnaire consisted of questions in seven domains:
154 (i) Knowledge of Influenza and Influenza Vaccination, (ii) Perceptions of Influenza Severity and
155 Susceptibility, (iii) Perceptions of Vaccination Barriers and Benefits, (iv) Willingness to Vaccinate,
156 (v) Vaccination Practices, (vi) Self-efficacy, and (vii) Cues to Vaccination. Response options for
157 questions in the Knowledge of Influenza domain were "True", "False", or "Not sure", while
158 questions in the Willingness to Vaccinate domain were on a 5-point Likert scale. For the majority
159 of other questions, responses were binary. On average, the questionnaire took 18 minutes to
160 complete.

161

162 *Data analysis*

163

164 The main outcome measures were participant-reported child influenza vaccination prevalence in
165 the past year, and at any time in the past. In addition, we conducted an analysis of factors
166 associated with ever having vaccinated one's child against influenza. We framed our analysis
167 around the Health Belief Model of health behaviour [23]. We hypothesised that children's
168 vaccination status is influenced by parents' demographic characteristics and knowledge of
169 influenza and influenza vaccine, their own influenza vaccination practices and willingness to
170 vaccinate their children, their perceptions of the severity of influenza and their children's

171 susceptibility to it, their perceptions of influenza vaccination benefits and barriers, as well as
172 external cues to action. A conceptual framework for this model is shown in Fig. 1.

173
174 Participants' knowledge was assessed using a 15-point knowledge score, with 1 point given for
175 each correctly answered knowledge question. To assess constructs of perceived severity and
176 susceptibility to influenza, and benefits of and barriers to vaccination, parents were presented
177 with a series of statements with which they were asked to agree or disagree. Willingness to
178 vaccinate was assessed using a series of 14 scenario questions. For each scenario, participants
179 were asked if they would definitely vaccinate their child, probably vaccinate, probably not
180 vaccinate, definitely not vaccinate, or were not sure. Each response was given a score ranging
181 from -2 (definitely would not vaccinate) to +2 (definitely would vaccinate), with 'not sure' given a
182 score of 0. The scores were averaged across all 14 scenarios to give a mean willingness score
183 ranging from -2 to +2.

184
185 We analysed the data using a Poisson model with robust standard errors [24]. The outcome
186 variable was ever having vaccinated the child against influenza. We estimated associations
187 between independent variables and the outcome using the prevalence ratio and corresponding
188 95% confidence interval (CI). In single variable analysis, we first regressed each explanatory
189 variable against the outcome and retained those for which there was moderate to strong evidence
190 of an association ($p < 0.2$). Within each domain of our conceptual framework, we then identified
191 the combination of variables that provided the best fit to the data, favouring the model with the
192 lowest value for Akaike's Information Criterion (AIC). In the final stage, we first included
193 demographic variables retained in the previous stage and sequentially added variables from each
194 subsequent domain, at each stage retaining those variables that yielded the model with the

195 lowest AIC. We did this iteratively until no further variables could be included in or excluded from
196 the model without resulting in an increase in the AIC. We did not explicitly test for effect
197 modification, as we had no a priori hypotheses for interactions between variables.

198

199 In addition, we conducted path analysis using generalised structural equation models to better
200 understand inter-relationships between variables. In particular, we fitted models to test two
201 competing hypotheses: that willingness to vaccinate and self-efficacy (feeling well-informed
202 about influenza vaccine) were influenced either by knowledge or by external cues (being
203 recommended influenza vaccination by a doctor or receiving influenza vaccine information from
204 a doctor's clinic).

205

206 Analyses were performed using Stata 14 (Stata Corporation).

207

208 *Ethics statement*

209

210 The study was approved by the Institutional Review Board of the National University of
211 Singapore (NUS-IRB Reference Code B-15-284, approval number NUS 2838). Informed consent
212 was obtained from participants at the beginning of the online questionnaire.

213 **Results**

214
215 A total of 447 responses to the online questionnaire were obtained. Of these 61 were excluded as
216 they were largely incomplete, indicating that the respondent had stopped completing the
217 questionnaire early on. Another 42 responses were excluded as the age of the child was <6
218 months. A further 12 responses were excluded because the respondent's age was above 45 years,
219 making it more likely for them to be the grandparents of the children. The remaining 332
220 responses were included in the analysis.

221 222 *Demographics*

223
224 Among the 332 respondents, 59% were aged 35 years and above and 79% were female. Those of
225 Chinese ethnicity comprised 82% of the sample, with Malays making up a further 6% and Indians
226 5%. In nearly three-quarters (72%) of responses, at least one of the parents had a university
227 degree. Nearly two-thirds (63%) of respondents lived in 3- to 5-bedrooms public housing
228 (Housing Development Board flats) and 28% lived in private condominiums (Table 1).

229 230 *Vaccine coverage*

231
232 Of the 332 respondents, 50 (15%; 95% CI: 11% - 19%) stated that their child had been
233 vaccinated against influenza in 2015, while 105 (32%; 95% CI: 27% - 37%) reported that their
234 child had received influenza vaccine at some point in the past.

235 236 *Knowledge, attitudes, and practices*

237

238 The median knowledge score was 12 out of 15, indicating that most parents were generally
239 knowledgeable about influenza and influenza vaccine. 88% of respondents were aware that there
240 was a vaccine for influenza.

241

242 Perceived susceptibility was high, with 83% of respondents believing that their child was
243 susceptible to catching influenza from their peers. Perceived benefit of the influenza vaccine and
244 severity of influenza were also relatively high; 70% of respondents believed that influenza
245 vaccine was effective in preventing their child from getting influenza and 67% stated that
246 influenza was a serious disease. However, a third of respondents felt that influenza was a mild
247 disease. A similar proportion of respondents also felt that influenza was not serious enough for
248 their child to warrant vaccination.

249

250 In addition, 5 potential barriers were evaluated. More than three-quarters of respondents were
251 more likely to vaccinate their child if it was offered at school. In addition, 40% respondents were
252 worried that their child had received too many vaccines, 39% were worried about the side effects
253 of the influenza vaccine, 27% were worried that the influenza vaccine would affect other
254 vaccinations, and 26% found the influenza vaccine to be too expensive. In addition, 64% of
255 respondents stated that they would be less likely to vaccinate their child against influenza if they
256 knew someone who had had a bad experience with the influenza vaccine.

257

258 Overall, willingness to vaccinate was high, with only 1.6% of parents stating that they would not
259 vaccinate their child against influenza under any of the scenarios presented.

260

261 Among 105 previously vaccinated children, 56% had been vaccinated at a private general practice
262 (GP) clinic, 19% at a government subsidised polyclinic, 16% at a private paediatric clinic, and
263 10% elsewhere. In contrast, when asked about their preferred locations for their child to receive
264 influenza vaccine, 58% of respondents stated a private GP clinic, 55% their child's school, and
265 37% a polyclinic.

266
267 The most commonly stated sources of information about influenza vaccine were the internet
268 (50%) and private GPs (47%). 33% of respondents had been recommended by a private GP or
269 paediatrician to vaccinate their child against influenza.

270

271 *Willingness to pay*

272

273 The median willingness to pay for one dose of child influenza vaccine was SGD30 (range SGD0 -
274 SDG300). Respondents whose child had been vaccinated in the past were generally willing to pay
275 a higher amount for one dose of influenza vaccine for their child (median SGD45, range SDG0-
276 SGD150) than respondents whose child had never been vaccinated (median SGD30, range SGD0-
277 SGD300) (Mann-Whitney U test $p = 0.0012$). When asked who should pay for the majority of the
278 cost for their child's influenza vaccine, 65% of respondents chose the government, 30% chose
279 parents, and 3% stated an equal share between parents and the government.

280

281 *Factors associated with child influenza vaccination*

282

283 Single variable associations between history of influenza vaccination and explanatory variables
284 are presented in supplementary table S1. In multivariable analysis, those recommended influenza

285 vaccination for their child by a private GP or paediatrician were 2.5 times more likely to have
286 vaccinated their child against influenza in the past (PR = 2.47, 95% CI: 1.75 - 3.48). Other factors
287 associated with increased vaccination prevalence were regularly taking pre-travel influenza
288 vaccine (PR = 1.64, 95% CI 1.19 - 2.25), having higher willingness to vaccinate (PR = 1.58, 95% CI:
289 1.24 - 2.04 per unit increase in willingness score), receiving influenza vaccine information from a
290 private GP clinic (PR = 1.47, 95% CI: 1.05 - 2.04), and feeling well-informed about influenza
291 vaccine (PR = 1.44, 95% CI: 1.04 - 1.99). Receiving influenza vaccination information from
292 television was associated with a lower prevalence of vaccination (PR = 0.44, 95% CI: 0.23 - 0.85)
293 (Table 2). No associations between vaccination and demographic or socioeconomic variables
294 were observed after adjusting for other variables.

295
296 Path analysis indicated that being recommended influenza vaccination by a private GP or
297 paediatrician positively influenced willingness to vaccinate ($\beta = 0.31$, $p = 0.001$), self-efficacy
298 (feeling well-informed about influenza vaccine; $\beta = 1.40$, $p < 0.001$) and regularly getting pre-
299 travel influenza vaccine ($\beta = 0.51$, $p = 0.043$) (Fig. 2). The latter was also positively influenced by
300 receiving influenza vaccine information from a private GP clinic ($\beta = 0.57$, $p = 0.018$). In contrast,
301 higher knowledge score did not influence any of these variables and was not associated with
302 vaccination after adjusting for other factors.

303 **Discussion**

304

305 This is the first study to report influenza vaccination coverage among young children in
306 Singapore. Our results indicate that vaccination coverage in this age group is low, with only a
307 third of children aged 6 months to 5 years old having received influenza vaccine in the past and
308 15% in the previous season. Published data from other countries indicate that child influenza
309 vaccination coverage in the Southeast Asia and Western Pacific regions is highly variable.
310 Estimates from Hong Kong are slightly higher than that in our study (21.1% coverage in the
311 2015/16 season) [25]. In contrast, an analysis of data on publicly purchased influenza vaccine in
312 Thailand found that about 3% and 1% of children aged 6-24 months had been vaccinated in 2010
313 and 2012 respectively [26], while a cross-sectional survey in Japan using an online panel
314 indicated 58% coverage among children aged <6 years [27].

315

316 Respondents demonstrated good knowledge of influenza and influenza vaccine. Lack of
317 convenience and perceived vaccine safety were identified as barriers to vaccination, indicating
318 that most parents would be in favour of influenza vaccination in schools, and that providing
319 authoritative information on the safety of the influenza vaccine could help address concerns
320 regarding vaccine safety.

321

322 Despite good knowledge and high willingness to vaccinate one's child against influenza, vaccine
323 uptake was low. This indicates that favourable knowledge and attitudes do not necessarily
324 translate into favourable vaccination practice. External cues, in particular recommendations by
325 medical professionals, are likely to be important for improving vaccine uptake. Being
326 recommended influenza vaccination by a child's physician was the most important determinant

327 of a child's vaccination status in this study, and we found evidence that it also positively
328 influences other determinants, including respondents feeling well-informed about the influenza
329 vaccine and their willingness to vaccinate their child. Conversely, although better knowledge of
330 influenza and influenza vaccine was initially associated with higher vaccination uptake, this effect
331 was no longer apparent after adjusting for physician's recommendation and other factors. This
332 indicates that enhancing cues from health care professionals, rather than simply providing
333 information to the public about influenza vaccination, is likely to be more effective for improving
334 uptake. Studies in Japan, Hong Kong, Thailand, US, and Turkey have all found physician's
335 recommendation to be significantly associated with a child being vaccinated against influenza
336 [27–33]. A nationally representative survey in Australia also found physicians to be the most
337 influential and important source of information for child vaccinations [34]. Despite this, only a
338 third of respondents in our study were recommended by a doctor to vaccinate their child against
339 influenza. Factors influencing physicians' recommendations of influenza vaccination for high-risk
340 groups have not been extensively studied and are poorly understood, particularly outside the
341 Western context. Previous studies suggest that lack of awareness of the severity of influenza [35],
342 lack of familiarity with vaccination guidelines [35,36], unfavourable perceptions of the risk and
343 efficacy of influenza vaccines [36,37], and perceived low profitability of clinic-based influenza
344 vaccination [38] are negatively associated with physicians' likelihood of recommending the
345 vaccine to children and pregnant women. Confusion about vaccination guidelines may be
346 compounded in tropical settings with year-round transmission, in which there may be additional
347 uncertainty regarding vaccination timing and composition [39,40].

348
349 Receiving influenza vaccination information from television was negatively associated with
350 vaccination. Respondents were not asked further about the exact source and type of information

351 obtained from television, and we are not aware of any formal campaigns through this medium.
352 Further studies would be better able to determine whether this association is due to differences
353 in the type of influenza-related information available on television and other media, or
354 differences in characteristics of respondents who obtain information from television versus other
355 means.

356
357 There were a number of limitations to this study. Firstly, our convenience survey sample was not
358 a random sample of all parents with children ≤ 5 years in Singapore. Despite a high pre-school
359 participation rate in Singapore, not all children attend pre-schools. Private pre-schools also
360 charge generally higher fees, so parents sending children to these pre-schools tend to be of higher
361 socioeconomic status than those who send children to publicly-funded pre-schools; 87 out of the
362 92 pre-schools who agreed to participate in this study were private pre-schools and around 70%
363 of our survey respondents had at least a university education, compared to about half of new
364 mothers in the Singapore Birth Registry [41]. Respondents of Chinese ethnicity were also over-
365 represented in our sample. As the survey was designed to be administered online, and we had no
366 information on how many parents had received and read the survey invitation, we could not
367 estimate the response rate; it is possible that parents with a greater interest in influenza vaccine
368 and those who had vaccinated their child in the past were more likely to respond to the survey.
369 This could have resulted in an overestimation of vaccine coverage. Despite this, vaccine uptake
370 was generally low and we did not find associations between any demographic or socioeconomic
371 variables and vaccination uptake in our data, suggesting that these are not the primary
372 determinants of vaccination in this population. Lastly, vaccination information was self-reported,
373 so it is possible that some misclassification of vaccination status occurred. However, this is
374 unlikely to have a significant impact on the results. Only a third of respondents were aware that

375 the child influenza vaccine is part of the Ministry of Health guidelines. Healthy adults are also not
376 in the recommended groups for influenza vaccination. Thus, it is unlikely that social desirability
377 bias resulted in respondents over-reporting their own or their child's positive vaccination status.
378 Respondents could have potentially mistaken the *Haemophilus influenzae type b* (Hib) vaccine for
379 the influenza vaccine when reporting their child's vaccination status, but this misclassification
380 would also be minimal as the Hib vaccine is given routinely in Singapore as part of a combination
381 vaccine, more commonly known as the 4-in-1 or 5-in-1 vaccine. We also expect parents' reporting
382 of their own vaccination status to be reasonably accurate, as receiving vaccinations is a rather
383 rare event for adults and therefore likely to be memorable.

384
385 The typical cost of a single dose of inactivated influenza vaccine in Singapore ranges from SGD35
386 to SGD50 (USD25 – USD35). Based on individuals' willingness to pay, approximately 33%-39% of
387 respondents would be prepared to pay that amount. However, it is unclear if respondents
388 understood that this is a recurring annual cost until the child reaches the age of 5 years. In
389 addition, the current recommendation is for previously unvaccinated children <9 years to receive
390 two doses in the first season for maximum protection [42–44]. While we do not have direct
391 evidence that cost is a barrier to vaccination, providing clearer messaging around options for
392 covering vaccination costs, including through Medisave, could help improve uptake among
393 parents who may be unaware of these options.

394 **Conclusions**

395
396 Our findings support the increasing body of evidence that encouraging doctors to recommend
397 child influenza vaccination to parents is key to improving vaccine uptake. Additional studies to
398 understand how physicians' own perceptions of influenza vaccine influence vaccination
399 recommendations for patients, and to identify effective ways to encourage cues to vaccination
400 from doctors would greatly inform interventions to increase influenza vaccination coverage in
401 children.

402

403 **Supplementary material: Supplementary Table S1**

404

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407

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410

411 **Conflict of interest**

412

413 The authors declare no conflict of interest.

414

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416

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418 University of Singapore, who conducted the fieldwork for this study.

419

420 **Author contributions**

421

422 CCT conceived the idea for the study. HT, CH, JQL, SC, SL, RT, MC, YT, and JZL led the team of
423 medical students who designed the study, developed the questionnaire, and carried out the
424 survey. ML and CCT analysed the data and drafted the manuscript. MH and CCT guided the design
425 of the study and survey questionnaire, and supervised the study. All authors read and approved
426 the final manuscript.

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- 554

1 Tables for:

2 **Parental perceptions of childhood seasonal influenza vaccination in Singapore: A cross-**
3 **sectional survey**

4

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6

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9 Jingzhan Lock

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11 **Content:**

12 Tables 1 and 2

13 **Table 1**

14 Demographic characteristics of 332 respondents to a survey of child influenza vaccination,

15 Singapore 2016.

16

	n	%
Age-groups		
20-29 years old	33	9.9
30-34 years old	103	31.0
35-39 years old	132	39.8
40-45 years old	64	19.3
Sex		
Female	261	78.6
Male	71	21.4
Ethnicity		
Chinese	272	81.9
Malay	20	6.0
Indian	15	4.5
Other	25	7.5
Father-of-child's highest education		
Below A Level/Diploma	38	11.4
A Level/Diploma	54	16.3
Degree and above	238	71.7
<i>Missing data</i>	2	0.6
Mother-of-child's highest education		

Below A Level/Diploma	26	7.8
A Level/Diploma	67	20.2
Degree and above	239	72.0
Housing type		
Public flats	209	63.0
Condominium	93	28.0
Landed property	29	8.7
<i>Missing data</i>	1	0.3
Monthly household income (in SGD)		
<\$6k	57	17.2
\$6-10k	96	28.9
\$10-14k	68	20.5
>\$14k	111	33.4
Child's grade		
Infant care (2 – 18 months old)	31	9.3
Nursery 1 & 2 (19 months – 4 years old)	191	57.5
Kindergarten 1 & 2 (5 – 6 years old)	104	31.3
<i>Missing data</i>	6	1.8

18 **Table 2**

19 Factors associated with influenza vaccination among children aged 6 months to 5 years attending
 20 pre-schools in Singapore in 2016, multivariable analysis

21

Variable	PR ¹	95% CI	<i>p</i> value
Recommended by physician to vaccinate child against influenza			
Yes	2.47	(1.75 - 3.48)	<0.001
No	1		
Family took pre-travel influenza vaccination			
Yes	1.64	(1.19 - 2.25)	0.003
No	1		
Willingness to vaccinate child against influenza			
Per unit increase from -2 to 2	1.59	(1.24 - 2.04)	<0.001
Received influenza vaccine information from private GPs			
Yes	1.47	(1.05 - 2.04)	0.023
No	1		
Felt well-informed about influenza vaccine			
Yes	1.44	(1.04 - 1.99)	0.026
No	1		
Received influenza vaccine information from television			
Yes	0.44	(0.23 - 0.85)	0.015
No	1		

22 ¹PR: prevalence ratio

23

1 Figure 1 for:

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10 **Figure 1** Conceptual framework on factors contributing to child being vaccinated against
11 influenza previously. For variables under each domain, see supplementary table S1.

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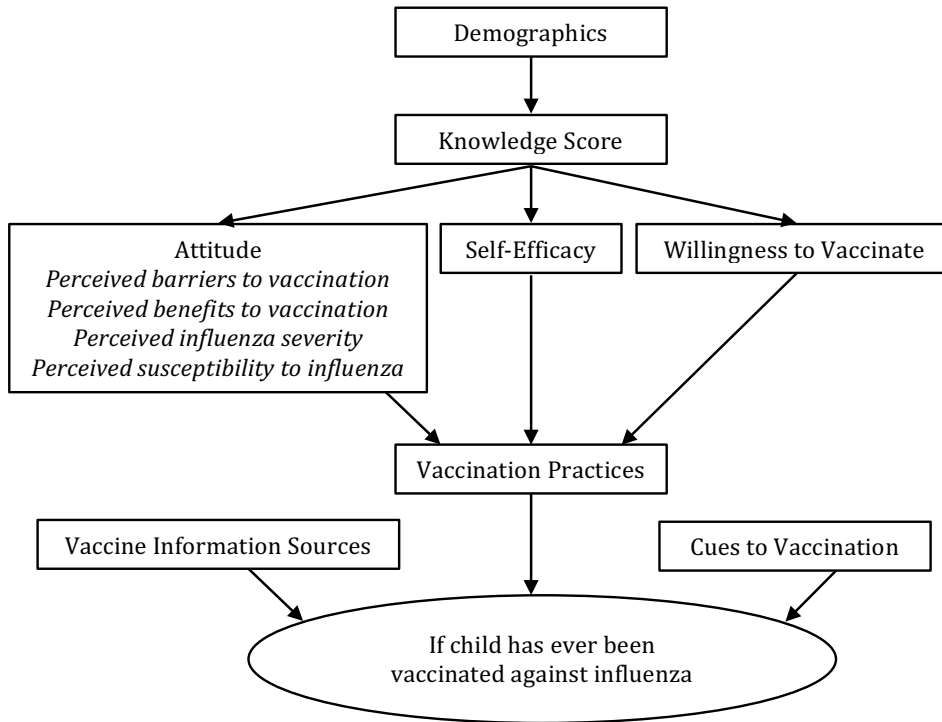


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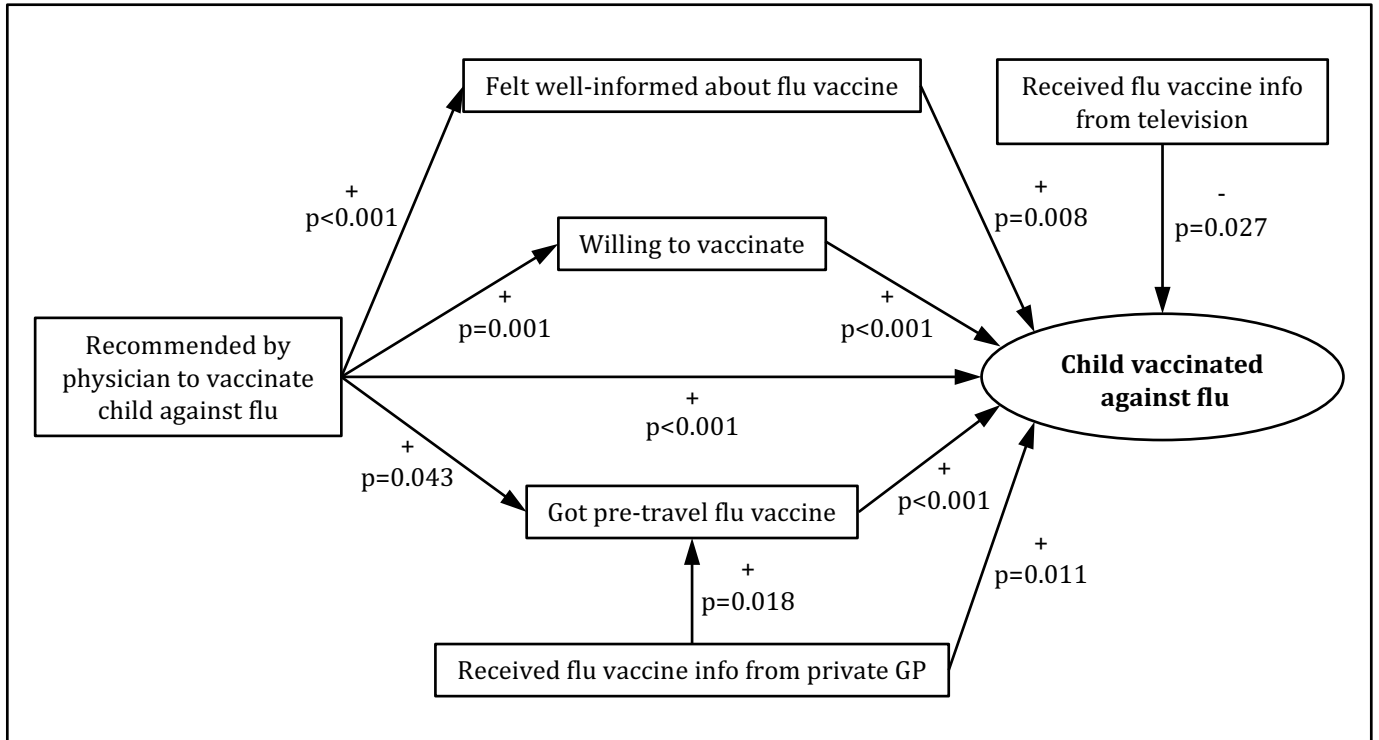
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Fig. 2. Relationships between determinants of child influenza vaccination among children aged 6 months to 5 years attending pre-schools in Singapore in 2016; results from structural equation modelling. (+) signs indicate positive associations, (-) signs indicate negative associations.



Supplementary material for:

Parental perceptions of childhood seasonal influenza vaccination in Singapore: A cross-sectional survey

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Content:

Supplementary table S1

Supplementary table S2

Supplementary table S3

Table S1

Factors associated with influenza vaccination among children aged 6 months to 5 years attending pre-schools in Singapore in 2016, single variable results

	Vaccinated		Total		<i>p</i> value ^c
	n	row % ^a	n	col % ^b	
Demographics					
Respondent's age					0.264
20-29 years old	8	24.2%	33	9.9%	
30-34 years old	36	35.0%	103	31.0%	
35-39 years old	46	34.8%	132	39.8%	
40-45 years old	15	23.4%	64	19.3%	
Respondent's sex					0.060
Female	76	29.1%	261	78.6%	
Male	29	40.8%	71	21.4%	
Respondent's Race					0.765
Chinese	87	32.0%	272	81.9%	
Non-Chinese	18	30.0%	60	18.1%	
Father's highest education					0.074
Below A Level/Diploma	17	44.7%	38	11.5%	
A Level/Diploma	12	22.2%	54	16.4%	
Degree and above	76	31.9%	238	72.1%	
Missing values			2		
Mother's highest education					0.310
Below A Level/Diploma	9	34.6%	26	7.8%	
A Level/Diploma	16	23.9%	67	20.2%	
Degree and above	80	33.5%	239	72.0%	
Housing type					0.722
Public flat	63	30.1%	209	63.1%	
Private condominium	32	34.4%	93	28.1%	
Landed property	10	34.5%	29	8.8%	

<i>Missing values</i>			1		
Monthly household income (in SGD)					0.039
<\$6k	15	26.3%	57	17.2%	
\$6-10k	22	22.9%	96	28.9%	
\$10-14k	23	33.8%	68	20.5%	
>\$14k	45	40.5%	111	33.4%	
Household size					0.397
2-3 household members	17	27.4%	62	18.7%	
4 household members	35	33.0%	106	32.0%	
5 household members	20	27.8%	72	21.8%	
6 household members	15	30.0%	50	15.1%	
≥7 household members	17	41.5%	41	12.4%	
<i>Missing values</i>	1		1		
Number of children below 5 years old					0.508
1	57	30.2%	189	56.9%	
≥2	48	33.6%	143	43.1%	
Father as main caregiver?					0.284
Yes	51	34.7%	147	44.3%	
No	54	29.2%	185	55.7%	
Mother as main caregiver?					0.916
Yes	79	31.5%	251	75.6%	
No	26	32.1%	81	24.4%	
Grandparent as main caregiver?					0.112
Yes	33	26.4%	125	37.7%	
No	72	34.8%	207	62.3%	
Maid as main caregiver?					0.306
Yes	31	36.0%	86	25.9%	
No	74	30.1%	246	74.1%	
Any smoker in family?					0.660
Yes	20	29.4%	68	20.5%	
No	85	32.2%	264	79.5%	
Frequency of family travelling overseas					0.042
1-2 times a year	37	25.7%	144	43.4%	
3-4 times a year	68	36.2%	188	56.6%	
Child's sex					0.936
Female	49	31.4%	156	47.0%	
Male	56	31.8%	176	53.0%	

Child's grade					0.386
Infant care	9	29.0%	31	9.3%	
Nursery 1/2	63	33.0%	191	57.5%	
Kindergarten 1/2	33	31.7%	104	31.3%	
Not schooling	0	0.0%	6	1.8%	
Knowledge Score ^d					
Knowledge score on flu and flu vaccine					0.001
Low scorers (<8 out of 15)	11	18.3%	60	18.1%	
Mid scorers (8-11 out of 15)	44	27.8%	158	47.6%	
High scorers (>11 out of 15)	50	43.9%	114	34.3%	
Attitude					
Perceived barrier - I worry that my child has been given too many vaccines.					0.006
Agree	31	23.1%	134	40.4%	
Disagree	74	37.4%	198	59.6%	
Perceived barrier - I worry about the side effects of the influenza vaccine (e.g. post-vaccine illness, sore arm).					0.014
Agree	31	23.8%	130	39.2%	
Disagree	74	36.6%	202	60.8%	
Perceived barrier - I am worried that the influenza vaccine might affect previous or future vaccinations (e.g. interactions, poorer efficacy).					0.147
Agree	23	25.6%	90	27.1%	
Disagree	82	33.9%	242	72.9%	
Perceived barrier - The influenza vaccine is too expensive (cost S\$35-\$50).					0.258
Agree	23	26.7%	86	25.9%	
Disagree	82	33.3%	246	74.1%	
Perceived barrier - I am more likely to vaccinate my child if it is offered at his/her school.					0.036
Agree	87	34.7%	251	75.6%	
Disagree	18	22.2%	81	24.4%	
Perceived benefit - I think that the influenza vaccine is effective in preventing influenza in my children.					<0.001
Agree	87	37.7%	231	69.6%	
Disagree	18	17.8%	101	30.4%	
Perceived severity - Influenza is a mild disease and is not serious.					0.012
Agree	25	40.3%	62	18.7%	
Disagree	73	32.9%	222	66.9%	
Not sure	7	14.6%	48	14.5%	
Perceived severity - I do not think that influenza is a serious enough disease to let my children take the vaccine.					<0.001

Agree	20	17.2%	116	34.9%	
Disagree	85	39.4%	216	65.1%	
Perceived susceptibility - I consider my children vulnerable to catching influenza from their peers.					0.242
Agree	91	33.0%	276	83.1%	
Disagree	14	25.0%	56	16.9%	
Self-Efficacy					
Perceived knowledgeability - I am well informed about the influenza vaccine.					<0.001
Agree	55	51.9%	106	31.9%	
Disagree	50	22.1%	226	68.1%	
Willingness to Vaccinate^e					
Willingness to vaccinate child in various scenarios					<0.001
Unwilling (Score of -2 to 0)	1	2.9%	34	10.7%	
Willing (Score of 0 to 1)	32	26.7%	120	37.7%	
Very willing (Score of 1 to 2)	69	42.1%	164	51.6%	
Missing values	3		14		
Vaccination Practices					
Frequency of family getting travel flu vaccination					<0.001
Never	43	20.3%	212	63.9%	
Sometimes/Always	62	51.7%	120	36.1%	
Respondent's last flu vaccination					<0.001
Less than 1 year ago	30	58.8%	51	16.1%	
1-2 years ago	18	40.9%	44	13.9%	
3-4 years ago	5	38.5%	13	4.1%	
More than 4 years ago	12	33.3%	36	11.4%	
Never vaccinated	32	18.5%	173	54.6%	
Missing values	8		15		
Vaccine Information Sources					
Internet as a source of information					0.036
Yes	43	26.1%	165	49.8%	
No	61	36.7%	166	50.2%	
Missing values	1		1		
GPs as a source of information					<0.001
Yes	69	44.8%	154	46.5%	
No	35	19.8%	177	53.5%	
Missing values	1		1		
Polyclinics/Hospitals as a source of information					0.950
Yes	34	31.2%	109	32.9%	
No	70	31.5%	222	67.1%	

<i>Missing values</i>	1		1		
Friends as a source of information					0.719
Yes	26	29.9%	87	26.3%	
No	78	32.0%	244	73.7%	
<i>Missing values</i>	1		1		
Health Promotion Board as a source of information					0.385
Yes	19	27.1%	70	21.1%	
No	85	32.6%	261	78.9%	
<i>Missing values</i>	1		1		
Newspapers as a source of information					0.010
Yes	11	17.7%	62	18.7%	
No	93	34.6%	269	81.3%	
<i>Missing values</i>	1		1		
Family as a source of information					0.840
Yes	16	32.7%	49	14.8%	
No	88	31.2%	282	85.2%	
<i>Missing values</i>	1		1		
Television as a source of information					0.004
Yes	6	13.0%	46	13.9%	
No	98	34.4%	285	86.1%	
<i>Missing values</i>	1		1		
School as a source of information					0.002
Yes	4	10.3%	39	11.8%	
No	100	34.2%	292	88.2%	
<i>Missing values</i>	1		1		
Magazines as a source of information					0.104
Yes	6	18.8%	32	9.7%	
No	98	32.8%	299	90.3%	
<i>Missing values</i>	1		1		
Books as a source of information					0.605
Yes	8	36.4%	22	6.6%	
No	96	31.1%	309	93.4%	
<i>Missing values</i>	1		1		
Cues to Vaccination					
Cue - Has your child's general practitioner or paediatrician recommended flu vaccination?					<0.001
Yes	68	61.8%	110	33.1%	
No	37	16.7%	222	66.9%	

Social norm - If I knew someone who has had a bad experience with the influenza vaccine, I would be less likely to vaccinate your child against influenza. 0.004

Agree	55	26.1%	211	63.6%
Disagree	50	41.3%	121	36.4%

- ^a Percentages are row percentages, i.e. vaccinated/total.
- ^b Percentages are column percentages.
- ^c All *P*-values are based on chi-square test.
- ^d Refer to Table S2 for questions to assess knowledge.
- ^e Refer to Table S3 for questions to assess willingness to vaccinate.

Table S2

List of statements to assess parental knowledge on influenza and the influenza vaccine

No.	Statement	Correct Response
1	Influenza is the same as common cold.	False
2	Influenza viruses are constantly changing and evolving.	True
3	Influenza can spread via droplets when the infected person speaks, sneezes or coughs.	True
4	Influenza can spread indirectly via sharing of food with an infected person.	True
5	Influenza can be spread via contact with virus-containing surfaces (e.g. doorknob, MRT handle) and then touching one's mouth or nose.	True
6	Influenza can lead to severe complications such as lung, middle ear and even brain infections.	True
7	Children with long term medical conditions like asthma are more susceptible to serious complications of influenza.	True
8	Children between 6 months to 5 years are less susceptible to serious complications of influenza.	False
9	The peak flu season in Singapore is generally from December to February and May to July.	True
10	Is there an influenza vaccine available?	Yes
11	The influenza vaccine is a vaccine that is a part of the MOH vaccination guidelines.	True
12	The influenza vaccine provides lifelong protection against influenza virus.	False
13	The protective effects of the influenza vaccine take place immediately after administration.	False
14a*	The side effects of the influenza vaccine include post-vaccine fever.	True
14b*	The side effects of the influenza vaccine include sore arm.	True
14c*	The side effects of the influenza vaccine include headache.	True
14d*	The side effects of the influenza vaccine include autism.	False
14e*	The side effects of the influenza vaccine include nausea and vomiting.	False
14f*	The side effects of the influenza vaccine include allergy.	False
15	The side effects of the influenza vaccine are usually serious.	False

* For statements 14a-14f, each correct response is worth one-sixth of a point.

Table S3

List of statements to assess parental willingness to vaccinate child against flu under each scenario

No.	Statement	Mean score*
1	If an influenza vaccine against a new worldwide influenza pandemic is made available.	1.32
2	If the Health Promotion Board offers annual influenza vaccinations free of charge as part of the Primary School Health Screening.	1.28
3	If an influenza outbreak has occurred in your child's school or childcare centre.	1.25
4	If there is strong evidence that influenza vaccination is effective in protecting your children from catching influenza.	1.25
5	If your child's doctor recommends your child to be vaccinated against influenza.	1.17
6	If annual influenza vaccination is now free of charge at government polyclinics.	1.09
7	If the government encourages the public to let their children take regular influenza vaccinations.	0.94
8	If the influenza vaccination is offered at a place close to your home.	0.79
9	If the influenza vaccine is delivered through a nose spray rather than an injection.	0.75
10	If households, where all their family members get their influenza vaccination regularly, will get some vouchers or discounts for purchases.	0.63
11	If you have other young children below the age of 5 at home.	0.63
12	If you have elderly parents living together at home.	0.55
13	If most of your child's friends have not taken the influenza vaccine.	0.35
14	If most of your own friends have not vaccinated their children against influenza.	0.29

* Mean willingness-to-vaccinate score for each scenario based on a 5-point Likert scale scored -2 (definitely would not vaccinate) to +2 (definitely would vaccinate)