RESEARCH PAPER

Illness representations on pneumonia and pneumococcal vaccination uptake among community-living Chinese people with high-risk conditions aged ≥ 65 years — a population-based study

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ABSTRACT

This study investigated the associations between illness representations of pneumonia and pneumococcal vaccination (PV) uptake among a group of community-living aging adults having at least one high-risk condition for severe invasive pneumococcal diseases (IPD). A total of 750 community-living Chinese-speaking individuals aged ≥ 65 y completed a random telephone survey. This study was based on 483 participants having at least one high-risk condition for severe IPD. The Illness Representation Questionnaire-Revised (IPQ-R) measured four dimensions of illness representations. These dimensions included timeline (whether pneumonia is believed to be acute/chronic), consequences (severity of pneumonia), treatment control (whether pneumonia is under volitional control), and emotional response (anger, guilty, or shame). Using PV uptake (among all participants) and behavioral intention to take up PV (among unvaccinated participants) as the dependent variables, logistic regression models were fitted. Among all participants ($n = 483$), 17.8% reported PV uptake; 18.6% of unvaccinated participants ($n = 397$) intended to take up two doses of free PV in the next year. After adjustment for significant background variables, participants who perceived more severe consequences of pneumonia (adjusted odds ratios, AOR: 1.18, 95%CI: 1.01, 1.40) and belief that treatment can control pneumonia (AOR: 1.41, 95%CI: 1.25, 1.58) reported higher PV uptake. Perceived pneumonia to be chronic (AOR: 1.44, 95%CI: 1.16, 1.78), belief that treatment can control pneumonia (AOR: 1.25, 95%CI: 1.12, 1.40) and having negative emotions related to pneumonia (AOR: 1.17, 95%CI: 1.09, 1.25) were positively associated with behavioral intention to take up PV. Results confirmed that illness representations were associated with PV-related behaviors.

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Introduction

Streptococcus pneumoniae is the most common cause of community-acquired pneumonia.¹ It causes noninvasive diseases such as otitis media, sinusitis, and pneumonia in most patients.¹ It can also cause invasive pneumococcal diseases (IPD), such as sepsis, meningitis, and bacteremic pneumonia.¹ In Hong Kong, China, pneumonia is the second leading cause of death in 2018 ($n = 8,334$), accounting for 17.6% of all registered deaths.² Individuals aged ≥ 65 y are at much higher risk of pneumococcal diseases (PD) and IPD and had the highest risk of death from IPD;^{3,4} 39.6% (75/189) of IPD were reported in this age group in 2018.⁵ Aging adults with some chronic conditions, such as history of IPD, immunocompromised states, chronic diseases, or cochlear implant are more vulnerable to severe IPD compared to those without these chronic conditions.⁶ Moreover, individuals aged ≥ 65 y are more susceptible to severe cases and deaths caused by seasonal influenza compared to their younger counterparts.⁷ Secondary bacterial pneumonia (mostly caused by

Streptococcus pneumoniae) are estimated to account for up to 50% of deaths during seasonal influenza.^{8–10}

The 13-valent pneumococcal conjugate vaccines (PCV13) and the 23-valent pneumococcal polysaccharide vaccine (23vPPV) are effective in preventing vaccine-type community-acquired pneumonia (vaccine efficacy: 45.6% for PCV13 and 44.8% for 23vPPV), pneumococcal pneumonia (vaccine efficacy for PCV13: 63.8%) and vaccine-type IPD (vaccine efficacy: 75% for PCV13 and 65% for 23vPPV) among individuals aged ≥ 65 y.^{11–13} Furthermore, receiving pneumococcal vaccination (PV) can prevent additional hospitalization and deaths due to seasonal influenza in elderly.¹⁴ Both types of PV are available in Hong Kong and their safety is well documented.¹⁵ One study projected that the provision of free PV would result in a savings of US\$18.0 million in health expenditures at a population level in Hong Kong.¹⁶ Therefore, provision of free PV to aging adults is likely cost-effective. In line with other international health guidelines, individuals aged ≥ 65 y in Hong Kong with at least one high-risk condition listed by the Department of Health but who have not received any PV are recommended to receive one dose of PCV13 followed by one dose of 23vPPV after 1 y.⁶ Those

without high-risk conditions are recommended by the Department of Health to receive only a single dose of PCV13 or 23vPPV.

In 2017, the Vaccination Subsidy Scheme and Government Vaccination Program were launched in Hong Kong. All community-living Hong Kong residents aged ≥ 65 y are eligible to receive subsidized PV (PCV13: HK\$730 (US\$94.2)/dose; 23vPPV: HK\$190 (US\$24.5)/dose) at enrolled private clinics. Those with high-risk conditions are eligible for free PV at public clinics.⁶ However, in Hong Kong, PV uptake was only 17.8% and 16.5% among community-living aging adults with and without high-risk condition of severe IPD, respectively, indicating the significant need for health promotion among this population.¹⁷

Previous studies have found a number of factors associated with PV uptake specifically among community-living individuals aged ≥ 65 y in other settings. Associated factors included socio-demographics (e.g., age, gender, household income, health insurance, and living arrangement),¹⁸ presence of comorbid conditions (e.g., chronic cardiovascular or respiratory diseases, diabetes mellitus, asthma) and lifestyle risk factors (e.g., smoking),¹⁹ and history of influenza vaccination. Knowledge and perceptions related to PV (e.g., awareness of PV and PV recommendations for aging adults, perceived efficacy, and safety concerns for PV).^{17,18,20,21} However, there is a dearth of studies investigating how aging adults conceptualize pneumonia and whether such perceptions and beliefs influence PV uptake.

Illness representations refer broadly to how people think about a disease or health condition. Growing evidence suggests that illness representation is important in explaining health behaviors. According to Leventhal's Common-Sense Model of Self-Regulation, individuals construct schematic representations of illness based on available information.²² This model suggests that a health threat (i.e., pneumonia) activates two types of illness representations: cognitive representations for regulating the objective threat and emotional representations to regulate emotions (e.g., anxiety and fear) arising as a result of the threat. Both types of illness representations guide the coping strategies used by an individual to deal with the health threat. Cognitive representations have six dimensions, including 1) identity (labeling the illness and identifying the symptoms), 2) cause (attributing likely causes of the illness), 3) timeline (considering whether the illness is acute/chronic), 4) consequences (assessing the severity of the illness), 5) treatment and personal control (considering whether the illness is under volitional control), and 6) illness coherence (overall comprehensibility of the illness). Emotional representations are defined as the extent to which individuals are emotionally affected by the illness (e.g., feeling anger, guilt, or shame).²³ This concept has also been expanded to explain health behaviors among healthy individuals, including uptake of influenza vaccination,^{24–26} hepatitis C virus testing,²⁷ cancer screening,²⁸ and self-care practices for chronic diseases.^{29,30} There is a dearth of studies investigating illness representations on pneumonia and association with PV uptake, a potential coping response. Since illness representations are modifiable through interventions,³¹

understanding aging adults' perceptions and beliefs of pneumonia can inform PV promotion efforts.

To the best of our knowledge, there are no studies investigating the association between illness representation and PV uptake among community-living Chinese aging adults. To address this gap, this study investigated prevalence of PV uptake and behavioral intention to receive two doses of free PV among a random sample of Hong Kong community-living aging adults with at least one high-risk condition for severe IPD, and associations with socio-demographic characteristics and illness representations related to pneumonia.

Methods

Participants and data collection

The current study is secondary analysis of a random telephone survey investigating PV uptake among community-living individuals aged ≥ 65 y in Hong Kong that was undertaken from May to July 2019.¹⁷ Participants of the random telephone survey were community-living Chinese-speaking individuals aged ≥ 65 y and had a Hong Kong ID card. Those who were not able to communicate effectively with the interviewers were excluded.

The random telephone survey was conducted by trained interviewers. Telephone numbers were selected from up-to-date Hong Kong telephone directories. Telephone interviews were conducted between 6:00–10:00 pm on weekdays and 2:00–9:00 pm on Saturdays during May to July 2019. If no one in the household answered the initial call, four more follow-up calls were made at different hours and days before it was considered as a non-valid household (one without an eligible participant). If there was more than one person in the household who was aged ≥ 65 y, the one whose last birthday was closest to the date of the interview was invited to join the study. Prospective eligible participants were briefed about the study. Interviewers confirmed that participants would remain anonymous, had the right to end participation in the study at any time, and that refusal would not have any consequences. Verbal instead of written informed consent was obtained. The interviewers signed a form pledging that the participants were fully informed about the study. The interview took about 20 minutes to complete. No incentive was provided to the participants. Ethics approval was obtained from the survey and behavioral research ethics committee of the Chinese University of Hong Kong (Reference No. SBRE-19-183).

Measures

Development of the questionnaire

A panel consisting of one public health researcher, one expert in behavioral health, one expert of pneumococcal diseases and vaccination, and one health psychologist was formed to design the questionnaire. The questionnaire was piloted among 20 eligible aging adults to examine its clarity and readability. Based on comments from pilot testing, the panel refined the questionnaire.

Background characteristics

Information collected included socio-demographics (age, gender, highest education level attained, marital status, current employment status, monthly household income, whether they lived alone) and lifestyle factors (smoking and binge drinking in the past year). Participants were also asked if they were receiving the Comprehensive Social Security Assistance (CSSA), which is a government social welfare scheme providing financial support to low-income people to meet basic needs. Participants were also asked about history of high-risk conditions for severe IPD listed by the Department of Health,⁶ history of pneumonia, and history of influenza vaccination.

PV uptake and behavioral intention to take up PV

History and number of doses of PV taken up by the participants were asked. Participants who had never received PV were briefed with the following: "In addition to pneumonia, *Streptococcus pneumoniae* causes severe diseases such as sepsis and meningitis. Taking up PV could reduce the risk of having these severe diseases by 65–75% among individuals aged ≥ 65 years." Participants were then asked about their likelihood of taking up two doses of free PV at public hospitals or clinics in the next year (response categories: 1 = very unlikely, 2 = unlikely, 3 = neutral, 4 = likely, 5 = very likely). We dichotomized the responses and defined behavioral intention as "likely" or "very likely."

Illness representations on pneumonia

The Illness Representation Questionnaire-Revised (IPQ-R) was used to measure participants' illness representations on pneumonia.³² The original IPQ-R had nine subscales: identity, consequences, timeline-chronic, timeline-cyclical, illness coherence, emotional representation, personal control, treatment control, and causal attribution. A Chinese version of the IPQ-R was validated and had satisfactory psychometric properties.³³ Due to the limited length of the questionnaire, four subscales were used in this study. These subscales were adapted by replacing "illness" in the original IPQ-R with "pneumonia." These subscales included 1) timeline-chronic (considering whether pneumonia is chronic, 5 items), 2) consequences (assessing the severity of pneumonia, 6 items), 3) treatment control (considering whether pneumonia can be controlled by existing treatment, 5 items), and 4) emotional representations (feeling of anger, anxiety, or depression related to pneumonia, 6 items). These subscales were chosen because they were found to be significant predictors of health-related behaviors in previous studies.^{24,34} Items of these subscales were rated on a 5-point Likert Scale from 1 = strongly disagree to 5 = strongly agree. Higher scores on timeline-chronic, consequences, and emotional representations indicated more negative illness representations, while a higher score on treatment control indicated more positive illness representations.

Data analysis

Descriptive data were presented for all studied variables. Using PV uptake (among all participants) and behavioral intention to

take up two doses of free PV at public hospitals or clinics in the next year (among unvaccinated participants) as dependent variables, crude odds ratios (OR) for the associations between background-independent variables and the dependent variables were estimated. Those background variables with $p < .05$ in the univariate analysis were adjusted for in subsequent multiple logistic regression analysis involving illness representations on pneumonia. Adjusted odds ratios (AOR) and respective 95% confidence intervals (CI) were derived from these analyses. SPSS version 16.0 was used for data analysis, with $p < .05$ indicating statistical significance.

Results

Background characteristics of the participants

A total of 1183 eligible participants were invited to join the study, 750 (response rate: 63.4%) completed the anonymous telephone survey. This study was based on 483 participants self-reporting as having at least one high-risk condition for IPD listed by the Department of Health.⁶ Most participants were more than 70-y old (63.6%), female (59.8%), without secondary education (84.5%), married or cohabitating with a partner (70.2%), with monthly income level lower than HK\$20,000 (US\$2,581) or receiving CSSA (96.9%), and living with another person (82.8%). Very few reported smoking (0.2%) or binge drinking (0.2%) in the past year. Chronic cardiovascular diseases (93.4%) and diabetes mellitus (28.8%) were the most commonly reported high-risk conditions for IPD. Over half had ever received seasonal influenza vaccination (53.8%). (Table 1)

PV uptake and behavioral intention to take up PV

Among the participants, 17.8% had taken up any dose of PV, and 6.4% had taken up two doses of PV. Among those who had never received PV ($n = 397$), 18.6% intended to take up two doses of free PV at public hospitals or clinics in the next year (Table 1).

Illness representations on pneumonia

Item responses and scale scores of illness representations on pneumonia are shown in Table 2. The Cronbach's alpha of these four subscales ranged from 0.627 to 0.926, single factors for each subscale were identified by exploratory factor analysis, explaining 66.4% to 77.5% of total variances.

Factors associated with PV uptake

In univariate analysis, older age (70–80 y: OR: 2.16, 95%CI: 1.21, 3.86; reference group: 65–70 y), higher education level attained (secondary school: OR: 2.17, 95%CI: 1.18, 3.99; reference group: primary school or below), and seasonal influenza vaccination uptake were associated with higher uptake of PV (OR: 107.83, 95%CI: 14.87, 782.06). Those who were married or cohabitating with a partner were less likely to take up PV compared to single participants (OR: 0.57, 95%CI: 0.33, 0.99). After adjustment for these variables, belief that treatment can control pneumonia (AOR: 1.18, 95%CI: 1.01, 1.40) and perceived consequences of

Table 1. Profiles of the participants ($n = 483$).

	<i>n</i>	%
Socio-demographics		
Age group (years)		
65–70	176	36.4
70–80	172	35.6
≥80	135	28.0
Gender		
Male	194	40.2
Female	289	59.8
Highest education level attained		
Primary school or lower	408	84.5
Secondary school	61	12.6
High diploma/undergraduate or higher	14	2.9
Marital status		
Married/cohabitation	339	70.2
Unmarried/divorced/widowed	144	29.8
Current employment status		
Full-time/part-time	18	3.7
Unemployed/retired/housewives	465	96.3
Monthly household income (HK\$)		
Receiving CSSA	32	6.6
<20,000	436	90.3
≥20,000	15	3.1
Living alone		
No	400	82.8
Yes	83	17.2
Lifestyles		
Cigarette smoking in the past year		
No	482	99.8
Yes	1	0.2
Binge drinking in the past year		
No	482	99.8
Yes	1	0.2
Self-reported history of high-risk conditions listed by the Department of Health (% Yes)		
Invasive pneumococcal diseases (IPD)	2	0.4
Cerebrospinal fluid leakage	2	0.4
Chronic cardiovascular diseases	451	93.4
Chronic lung diseases	1	0.2
Chronic liver diseases	0	0.0
Chronic kidney diseases	5	1.0
Diabetes Mellitus	139	28.8
Immunocompromised states	1	0.2
Number of high-risk conditions listed by Department of Health		
1	336	69.6
2	118	24.4
≥3	29	6.0
History of pneumonia and vaccination		
History of pneumonia	479	99.2
No	4	0.8
Yes		
Family member/friend had history of pneumonia		
No	479	99.2
Yes	4	0.8
Uptake of seasonal influenza vaccination		
No	223	46.2
Yes	260	53.8
Number of doses of PV taken up by elderly individuals with at least one high-risk conditions listed by the Department of Health ($n = 483$)		
0	397	82.2
1	55	11.4
2	31	6.4
Behavioral intention to take up two doses of free PV at public hospitals/clinics in the next year (among those who had never received PV, $n = 397$)		
Very unlikely/unlikely/neutral	323	81.4
Likely/very likely	74	18.6

CSSA: Comprehensive Social Security Assistance

pneumonia to be severe (AOR: 1.41, 95%CI: 1.25, 1.58) were associated with higher uptake of PV (Table 3–4).

Table 2. Item responses of illness representations on pneumonia ($n = 483$).

	%	Mean (SD)
Timeline-chronic (considering whether pneumonia is chronic) (% agree/strongly agree)		
Pneumonia will last a short time (R)	4.6	
Pneumonia is likely to be permanent rather than temporary	3.5	
Pneumonia will last for a long time	7.5	
Pneumonia will pass quickly (R)	3.5	
Pneumococcus will exist in my body for the rest of my life	0.8	
<i>Timeline (Mean/SD)</i>		14.9 (1.3)
Consequence (assessing the severity of pneumonia) (% agree/strongly agree)		
Pneumonia is a serious condition	15.9	
Pneumonia has major consequences on my life	7.5	
Pneumonia does not have much effect on my life (R)	3.9	
Pneumonia strongly affects the way others see me	1.7	
Pneumonia has serious financial consequences	10.8	
Pneumonia causes difficulties for those who are close to me	14.7	
<i>Consequence (Mean/SD)</i>		18.3 (1.7)
Treatment control (considering whether pneumonia can be controlled by existing treatment) (% agree/strongly agree)		
There is very little that can be done to cure pneumonia (R)	2.1	
Treatment will be effective in curing pneumonia	22.2	
The negative effects of pneumonia can be avoided by treatment	22.4	
Treatment can control pneumonia	24.2	
There is nothing which can help for curing pneumonia (R)	2.9	
<i>Treatment control (Mean/SD)</i>		16.2 (2.4)
Emotional representation (negative feeling due to pneumonia) (% agree/strongly agree)		
I get depressed when I think about pneumonia	38.1	
When I think about pneumonia, I get upset	35.6	
Pneumonia makes me feel angry	17.8	
Pneumonia does not worry me (R)	6.4	
Having pneumonia makes me feel anxious	28.4	
Pneumonia makes me feel afraid	39.3	
<i>Emotional representation (Mean/SD)</i>		18.3 (4.5)

R: reverse scoring, SD: standard deviation

Items of the subscales on timeline-chronic, consequences, treatment control, and emotional responses were rated on a 5-point Likert Scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

Higher scores on timeline-chronic, consequences and emotional representation indicated more negative illness representations. Higher score on treatment control indicated more positive illness representations.

Factors associated with behavioral intention to take up PV

Among those who had never received PV, highest education level attained (secondary school: OR: 2.47, 95%CI: 1.23, 4.96; reference group: primary school or below) and being married or cohabitating with a partner (OR: 0.49, 95%CI: 0.26, 0.90) were significantly associated with behavioral intention to take up two doses of free PV at public hospitals or clinics in the next year. After adjusting for these two variables, perception of pneumonia as a chronic disease (AOR: 1.44, 95%CI: 1.16, 1.78), consequence of pneumonia to be severe (AOR: 1.25, 95%CI: 1.12, 1.40), and having negative emotional representations of pneumonia (AOR: 1.17, 95%CI: 1.09, 1.25) were more likely to have behavioral intention to take up PV (Table 3–4).

Discussion

Although free PV is provided by government programs to community-living aging adults with high-risk conditions of

Table 3. Associations between participants' profiles and past behaviors/behavioral intention to take up PV.

	Uptake of at least one dose of PV (n = 483)		Behavioral intention to take up two doses of free PV at public clinics/hospitals in the next year (n = 397)	
	Row%	OR (95%CI)	Row%	OR (95%CI)
Socio-demographics				
Age group (years)				
65–70	11.9	1.0	20.6	1.0
70–80	22.7	2.16 (1.21, 3.86)**	18.8	0.89 (0.50, 1.60)
≥80	19.3	1.76 (0.94, 3.29)†	15.6	0.71 (0.37, 1.36)
Gender				
Male	20.1	1.0	16.1	1.0
Female	16.3	0.77 (0.48, 1.24)	20.2	1.32 (0.78, 2.24)
Highest education level attained				
Primary school or lower	16.2	1.0	16.4	1.0
Secondary school	29.5	2.17 (1.18, 3.99)*	32.6	2.47 (1.23, 4.96)*
High diploma/undergraduate or higher	14.3	0.86 (0.19, 3.95)	33.3	2.55 (0.74, 8.77)
Marital status				
Unmarried/divorced/widowed	20.1	1.0	21.8	1.0
Married/cohabitation	12.5	0.57 (0.33, 0.99)*	11.9	0.49 (0.26, 0.90)*
Current employment status				
Unemployed/retired/housewives	5.6	1.0	29.4	1.0
Full-time/part-time	18.3	3.80 (0.50, 28.97)	18.2	0.53 (0.18, 1.56)
Monthly household income (HK\$)				
Receiving CSSA	9.4	1.0	17.2	1.0
<20,000	18.3	2.17 (0.65, 7.31)	18.5	1.09 (0.40, 2.97)
≥20,000	20.0	2.42 (0.43, 13.71)	25.0	1.60 (0.32, 8.11)
Living alone				
No	19.3	1.0	18.3	1.0
Yes	10.8	0.51 (0.25, 1.06) ^a	20.3	1.14 (0.60, 2.14)
Lifestyles				
Cigarette smoking in the past year				
No	17.8	1.0	18.7	1.0
Yes	0.0	N.A.	0.0	N.A.
Binge drinking in the past year				
No	17.8	1.0	18.7	1.0
Yes	0.0	N.A.	0.0	N.A.
History of pneumonia and influenza vaccination				
History of pneumonia				
No	17.7	1.0	18.5	1.0
Yes	25.0	1.55 (0.16, 15.04)	33.3	2.20 (0.20, 24.57)
Family member/friend had history of pneumonia				
No	17.7	1.0	18.5	1.0
Yes	25.0	1.55 (0.16, 15.04)	33.3	2.20 (0.20, 24.57)
Uptake of seasonal influenza vaccination				
No	0.4	1.0	15.3	1.0
Yes	32.7	107.83 (14.87, 782.06)***	22.9	1.64 (0.99, 2.72)†
Number of high-risk conditions listed by Department of Health				
1	20.5	1.0	18.4	1.0
2	13.6	0.61 (0.34, 1.10)†	21.6	1.22 (0.70, 2.15)
≥3	3.6	0.14 (0.02, 1.07)†	11.1	0.56 (0.16, 1.92)

OR: crude odds ratios

^a0.05 < p < 0.10, *P < 0.05, **P < 0.01, ***P < 0.001

IPD, very few have received PV, and even fewer completed two doses of PV as recommended by the Department of Health.⁶ This prevalence was much lower than that of the United States (64.0–74.7%),³⁵ Canada (58.0%)³⁶ or Australia (43.2–72.8%).³⁷ Moreover, less than 20% of unvaccinated participants had behavioral intention to take up free PV in the next year. Since only 43–62% of those with a behavioral intention would eventually translate the intention into a relevant action,³⁸ very few would actually take up PV. Our findings indicate the significant need for health promotion for this population, even given the availability of free PV.

Similar to findings of previous studies, history of seasonal influenza vaccination was associated with higher PV uptake.^{17,18,20} Given the fact that secondary and co-infection of pneumonia (mostly caused by *Streptococcus pneumoniae*)

during seasonal influenza is common and associated with higher risk of death, future programs should simultaneously promote PV and seasonal influenza. Aging adults with higher education levels were more receptive to the governmental PV program, as they reported higher PV uptake and higher behavioral intention to take up PV compared to those with lower education levels. These findings are expected as those with higher education levels can better understand health communication messages delivered by the governmental program. Since a large proportion of aging adults in Hong Kong did not receive secondary education, health communication messages promoting PV should be simple and straightforward. In particular, pilot testing of health communications messages among aging adults with low education levels is necessary. Additionally, married or cohabitating with a partner was

Table 4. Associations between illness representations and past behaviors/behavioral intention to take up PV.

	Uptake of at least one dose of PV (n = 483)		Behavioral intention to take up two doses of free PV at public clinics/hospitals in the next year (n = 397)	
	OR (95%CI)	AOR (95%CI)	OR (95%CI)	AOR (95%CI)
Timeline-chronic	1.21 (0.99, 1.47) ^a	1.24 (0.97, 1.58) ^a	1.54 (1.23, 1.89) ^{***}	1.44 (1.16, 1.78) ^{**}
Consequence	1.18 (1.03, 1.35) [*]	1.18 (1.01, 1.40) [*]	0.92 (0.79, 1.07)	–
Treatment control	1.35 (1.24, 1.47) ^{***}	1.41 (1.25, 1.58) ^{***}	1.29 (1.17, 1.43) ^{***}	1.25 (1.12, 1.40) ^{***}
Emotional representation	1.05 (1.00, 1.11) [*]	1.06 (0.98, 1.14)	1.15 (1.08, 1.22) ^{***}	1.17 (1.09, 1.25) ^{***}

OR: crude odds ratios

AOR: odds ratios adjusted for significant background variables listed in Table 3.

^a0.05 < *p* < 0.10, ^{*}*p* < 0.05, ^{**}*p* < 0.01, ^{***}*p* < 0.001*P* > 0.05 in univariate analysis and not considered in the model

associated with lower PV uptake and lower behavioral intention to take up PV. Future studies should explore partner's influences on vaccination behaviors among aging adults.

The Common-Sense Model of Self-Regulation suggests that illness representations are amenable through interventions.²² Our findings highlight the potential to modify illness representations of pneumonia to promote PV uptake among aging adults with high-risk conditions for IPD. In terms of timeline, very few participants considered pneumonia to be a chronic disease. This finding was expected as prior research found that Chinese participants perceived pneumonia as an acute illness.³⁹ The association between perception of a chronic timeline and PV uptake was of marginal statistical significance. Perception of a chronic timeline of pneumonia was also associated with higher behavioral intention to take up PV among unvaccinated participants. It is possible that aging adults believe that a chronic timeline results in an extended period of suffering, and necessitating the need prevent such suffering from happening (i.e., by taking up PV). Future health promotion related to PV uptake should emphasize the potentially lengthy recovery period from pneumonia for aging adults, especially those who have additional chronic conditions.⁴⁰ Although effective treatments are available,⁴¹ only about 20% of the participants agreed that pneumonia could be controlled by existing treatments. The dimension of treatment control was associated with both PV uptake among all participants and behavioral intention to take up PV among unvaccinated aging adults. In general, treatment control is significantly associated with uptake of seasonal influenza vaccination,²⁴ hepatitis C virus testing,²⁷ and treatment adherence to some chronic diseases (e.g., asthma, hypertension).²⁹ Beliefs in treatment control of pneumonia may be related to perceived efficacy of PV, which has shown to be significantly associated with behaviors and intentions related to PV.²¹ Similar to previous findings,^{42,43} severe consequences of pneumonia were neglected by the participants. Higher scores on the dimension of "consequence" were associated with higher uptake of

hepatitis C virus testing. However, the association between this dimension and behavioral intention to take up PV was non-significant among unvaccinated participants. Emphasizing the severity of consequences of pneumonia may not be a useful strategy to motivate unvaccinated aging adults to take up PV.

In our study, pneumonia strongly elicited negative emotions among participants. The importance of these negative emotions is illustrated by the significant association between negative emotions related to pneumonia and behavioral intention to take up PV among unvaccinated participants. A similar association was found between emotional representations and behavioral intention to take up seasonal influenza vaccination among the general population in Hong Kong.²⁴ To promote PV, it may be useful to promote positive coping strategies that are designed to reduce the negative emotions associated with pneumonia among elderly. It is possible to guide those with high levels of negative emotions to take up PV as a positive coping response, hence transferring negative emotions into preventive health behaviors.

Limitations

This study had some limitations. First, non-response may introduce selection bias. Our response rate was relatively high (63.4%) as compared to other random telephone surveys on similar topics.^{44,45} Second, data was self-reported and verification was not feasible. Recall bias might exist. Third, due to the limited length of the questionnaire, we did not measure all dimensions of illness representation. Fourth, causality could not be established as this was a cross-sectional study.

Conclusion

This was one of the first studies investigating illness representations on pneumonia and PV uptake. Although free PV is provided to community-living aging adults with high-risk conditions for IPD, this group reported very low PV uptake and behavioral intention to take up PV. Dimensions of illness representations, including belief that timeline of pneumonia is chronic, understanding the severe consequences of pneumonia, knowing that pneumonia can be controlled with treatment, and having negative emotions related to pneumonia were significantly associated with PV uptake and/or behavioral intention to take up PV among community-living aging adults with high-risk condition of IPD in Hong Kong.

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