Online intervention to increase seasonal influenza vaccination among community-dwelling older people: a randomised controlled trial (abridged secondary publication)

Z Wang *, JTF Lau, PKH Mo, Q Zhang, MCS Wong

KEY MESSAGES

1. A stage-customised online intervention based on the trans-theoretical model was more effective than a standard, non-stage-customised online intervention in increasing seasonal influenza vaccination uptake among community-dwelling individuals aged ≥65 years.
2. Compliance with the intervention and changes in constructs of the trans-theoretical model fully or partially mediated the effects of the intervention.
3. A WhatsApp-based chatbot was a highly feasible and acceptable tool for promoting health among older adults.

Hong Kong Med J 2024;30(Suppl 7):S4-8
HMRF project number: 19181152

[1] Z Wang, [1] JTF Lau, [1] PKH Mo, [2] Q Zhang, [1] MCS Wong

[1] *Jockey Club School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong SAR, China*
[2] *School of Data Science, City University of Hong Kong, Hong Kong SAR, China*

* Principal applicant and corresponding author: wangzx@cuhk.edu.hk

Introduction

Seasonal influenza epidemics cause 3 to 5 million cases of severe illness and 290 000 to 650 000 deaths annually worldwide.[1] In Hong Kong, the flu season usually lasts from January to March and from July to August[2]; severe illness and death mainly affect individuals aged ≥65 years.[3] Seasonal influenza was a serious health threat during the COVID-19 pandemic.[4] Seasonal influenza vaccination (SIV) is effective and safe for older adults. However, SIV coverage remains low among older adults in Hong Kong.

The trans-theoretical model (TTM) was used to guide the development of our SIV uptake promotion.[5] A chatbot is a programme that can automatically select and deliver customised intervention pathways according to participants' responses, enabling the provision of personalised, engaging, and on-demand health promotion. A chatbot can be designed to deliver a customised online intervention for promoting SIV among older adults. It can assess a user's stage of change (SOC) regarding SIV uptake and disseminate customised interventions through instant messaging platforms (eg, WhatsApp). This fully automated approach is cost-effective and can deliver multiple sessions of stage-customised intervention.

This randomised controlled trial was conducted to compare the efficacy between a stage-customised online intervention and a standard, non-stage-customised online intervention in promoting SIV uptake among community-dwelling individuals aged ≥65 years. Additionally, we evaluated the efficacy of the intervention in increasing behavioural intention to receive SIV and in modifying constructs related to the TTM during follow-up.

Methods

A non-blinded, two-arm parallel randomised controlled trail was conducted in Hong Kong between November 2021 and July 2022. Community-dwelling, Chinese-speaking older adults aged ≥65 years who owned a smartphone and had not received SIV for the upcoming flu season were invited to participate through random telephone sampling. Individuals who had cognitive impairment, blindness or deafness, inability to communicate with others effectively, or known contraindications for SIV were excluded.

Household numbers were randomly selected from the most recent telephone directories. In households with more than one person aged ≥65 years, the individual whose last birthday was closest to the interview date was invited to participate. Participants were randomly assigned to either the intervention group or the control group via the chatbot algorithm. Participants were interviewed by telephone at baseline and at 3 and 6 months after completion of the intervention.

In the control group, the chatbot provided a link to access a standard online video (approximately 2 minutes) covering basic information about SIV (who, when, and where to receive SIV) at weeks 0, 2, 4, and 6. In the intervention group, the chatbot delivered one of several SOC-customised online health promotion videos regarding SIV uptake, once every 2 weeks for four sessions, through WhatsApp at weeks 0, 2, 4, and 6. At the start of each session, the chatbot assessed the participant's

SOC. Beginning with the second session, the chatbot also asked whether the participant had received SIV for the upcoming flu season. If the participant clicked 'yes', the chatbot recorded this response and automatically ended the programme. Otherwise, the chatbot provided a link to an SOC-customised health promotion video through WhatsApp.

The primary outcome measure was the prevalence of self-reported seasonal influenza vaccine uptake at month 6. This outcome was validated by requesting participants to upload an image of their SIV receipt. Secondary outcome measures included behavioural intention to receive SIV in the next year, perceived pros and cons and self-efficacy of SIV, SOC related to SIV, and compliance with the intervention.

An intention-to-treat analysis was performed. Missing data regarding SIV uptake were treated as non-uptake. The Markov Chain Monte Carlo method was used to impute missing data regarding secondary outcomes. Chi-square tests or independent-samples *t* tests were used to compare the groups. Relative and absolute risk reductions and the number needed to treat were calculated. Logistic regression (for binary variables) and linear regression models (for continuous variables) were used to explore between-group difference in outcomes after adjustment for any confounders. We evaluated whether changes in SOC, perceived pros and cons, and self-efficacy mediated between-group differences in the prevalence of SIV uptake at month 6. Hypotheses were tested using the Baron and Kenny's approach.

Results

Of 3963 households contacted, 698 included an eligible older adult. Of these, 396 (56.7%) completed the baseline telephone survey and were randomly assigned to either the intervention group (n=198) or the control group (n=198). At month 6, 339 participants completed the telephone follow-up survey; the dropout rates were 14.4% overall, 16.7% in the control group, and 12.1% in the intervention group. Participants with no history of SIV or pneumococcal vaccination or with fewer doses of SIV in the past 3 years were more likely to drop out.

The control and intervention groups were comparable in terms of all baseline characteristics, except for the Perceived Self-efficacy Scale score (P=0.03, Table 1). At month 6, the SIV uptake rate was higher in the intervention group than in the control group (50.5% vs 35.4%, relative risk reduction=1.43, absolute risk reduction=0.15, number needed to treat=6.6, P=0.002, Table 2).

At month 6, the intervention group had larger proportions of participants who completed at least one episode of intervention (77.3% vs 62.6%, P<0.001), were at a higher SOC (P=0.001), and reported higher perceived pros (P=0.001) and self-efficacy (P=0.01) but lower perceived cons (P=0.002). Regarding changes in perception based on the TTM, the intervention group displayed a smaller increase in Perceived Cons Scale score (P=0.02), smaller decreases in Perceived Pros Scale score (P=0.007) and Perceived Self-Efficacy Scale score (P=0.01), and a larger increase in SOC (P=0.01) [Table 3]. However, the two groups were comparable in terms of behavioural intention to receive SIV in the next 6 months among participants who had not received SIV (39.8% vs 35.9%, P=0.56).

After adjusting for changes in self-efficacy and SOC, the association between intervention status and SIV uptake was no longer significant. This suggests that changes in self-efficacy and SOC mediated the effect of intervention. The association between intervention status and SIV uptake also weakened after adjusting for changes in perceived pros (from P=0.001 to P=0.01), perceived cons (from P=0.001 to P=0.02), and completion of at least one episode of intervention (from P=0.001 to P=0.01). Perceived pros, perceived cons, and completion of at least one episode of intervention remained significant (P<0.001), which indicated partial mediation.

Discussion

Our study evaluated the efficacy of a chatbot-delivered, theory-based intervention to increase SIV uptake among community-dwelling older adults in Hong Kong. Compared with the control group, the intervention group showed a significant increase in SIV uptake. Our intervention was fully automated and required minimal resources to implement or maintain. The chatbot can be easily integrated with governmental webpages that provide SIV-related information, as well as WhatsApp groups.

A WhatsApp-based chatbot was acceptable for delivering health promotion to older adults. The chatbot-delivered intervention was well-received, and most participants did not encounter any difficulties in using the chatbot. The level of compliance with the intervention, changes in SOC, and changes in perceived pros and cons and self-efficacy mediated the effect of intervention. These results also extended the applicability of the TTM.

This study had several limitations. First, the COVID-19 pandemic and COVID-19 vaccine rollout might have influenced the study outcome. Nonetheless, these effects were expected to be similar across the two groups. Second, participation was limited to older adults with smartphone access. Third, people aged ≥75 years were under-sampled. Fourth, selection bias may have resulted from non-responses. Fifth, attrition bias might be present because those who dropped out of the intervention group were less likely to report a history of SIV at baseline, compared with those who did not drop out. However, our study's strengths included a population-based representative

TABLE 1. Baseline characteristics of participants and seasonal influenza vaccination (SIV) uptake

Characteristic	All (n=396)*	Intervention group (n=198)*	Control group (n=198)*	P value
Age, y				0.78
65-69	201 (50.8)	104 (52.5)	97 (49.0)	
70-74	134 (33.8)	65 (32.8)	69 (34.8)	
≥75	61 (15.4)	29 (14.6)	32 (16.2)	
Sex				0.12
Male	147 (37.1)	81 (40.9)	66 (33.3)	
Female	249 (62.9)	117 (59.1)	132 (66.7)	
Relationship status				0.17
Currently single	106 (26.8)	47 (23.7)	59 (29.8)	
Married or cohabiting with a partner	290 (73.2)	151 (76.3)	139 (70.2)	
Education level				0.54
Primary or below	164 (41.4)	86 (43.4)	78 (39.4)	
Secondary	189 (47.7)	89 (44.9)	100 (50.5)	
Tertiary or above	43 (10.9)	23 (11.6)	20 (10.1)	
Monthly household income, HK$				0.70
<20 000	294 (74.2)	144 (72.7)	150 (76.1)	
≥20 000	52 (13.1)	27 (13.6)	25 (12.7)	
Undisclosed	50 (12.6)	27 (13.6)	23 (11.6)	
Receiving Comprehensive Social Security Assistance				0.45
No	366 (92.4)	185 (93.4)	181 (91.4)	
Yes	30 (7.6)	13 (6.6)	17 (8.6)	
Living alone				0.52
No	321 (81.1)	158 (79.8)	163 (82.3)	
Yes	75 (18.9)	40 (20.2)	35 (17.7)	
Smoking in the past year				0.84
No	369 (93.2)	185 (93.4)	184 (92.9)	
Yes	27 (6.8)	13 (6.6)	14 (7.1)	
Binge drinking in the past year				0.74
No	387 (97.7)	194 (98.0)	193 (97.5)	
Yes	9 (2.3)	4 (2.0)	5 (2.5)	
Comorbidity				
Hypertension	189 (47.7)	100 (50.5)	89 (44.9)	0.27
Chronic cardiovascular diseases	42 (10.6)	19 (9.6)	23 (11.6)	0.51
Chronic lung diseases	8 (2.0)	6 (3.0)	2 (1.0)	0.15
Chronic liver diseases	8 (2.0)	5 (2.5)	3 (1.5)	0.48
Chronic kidney diseases	3 (0.8)	2 (1.0)	1 (0.5)	0.56
Diabetes mellitus	75 (18.9)	39 (19.7)	36 (18.2)	0.70
Any of above	239 (60.4)	127 (64.1)	112 (56.6)	0.12
History of COVID-19				0.41
No	390 (98.5)	196 (99.0)	194 (98.0)	
Yes	6 (1.5)	2 (1.0)	4 (2.0)	
History of SIV				0.18
No	159 (40.2)	73 (36.9)	86 (43.4)	
Yes	237 (59.8)	125 (63.1)	112 (56.6)	

* Data are presented as mean ± standard deviation or No. (%) of participants

TABLE 1. (cont'd)

Characteristic	All (n=396)*	Intervention group (n=198)*	Control group (n=198)*	P value
No. of doses of SIV received in the past 3 years				0.21
0	180 (45.5)	86 (43.4)	94 (47.5)	
1	33 (8.3)	14 (7.1)	19 (9.6)	
2	48 (12.1)	21 (10.6)	27 (13.6)	
3	135 (34.1)	77 (38.9)	58 (29.3)	
History of pneumococcal vaccination				0.73
No	293 (74.0)	145 (73.2)	148 (74.7)	
Yes	103 (26.0)	53 (26.8)	50 (25.3)	
No. of doses of COVID-19 vaccine received				0.76
0	153 (38.6)	76 (38.4)	77 (38.9)	
1	8 (2.0)	3 (1.5)	5 (2.5)	
2	235 (59.3)	119 (60.1)	116 (58.6)	
Perceived pros of SIV				
SIV is highly effective in protecting me from seasonal influenza	253 (63.9)	130 (65.7)	123 (62.1)	0.46
SIV is highly effective in preventing severe consequences of seasonal influenza	272 (68.7)	141 (71.2)	131 (66.2)	0.28
SIV is highly effective in protecting my family members from seasonal influenza	194 (49.0)	97 (49.0)	97 (49.0)	1.00
Perceived Pros Scale score	7.4±1.8	7.5±1.7	7.4±1.8	0.78
Perceived cons of SIV				
SIV has severe side effects	28 (7.1)	11 (5.6)	17 (8.6)	0.24
SIV is too expensive for me	8 (2.0)	3 (1.5)	5 (2.5)	0.48
It is inconvenient for me to receive SIV	13 (3.3)	7 (3.5)	6 (3.0)	0.78
My health conditions are not suitable for receiving SIV	65 (16.4)	34 (17.2)	31 (15.7)	0.68
SIV would negatively impact the effectiveness of COVID-19 vaccination	24 (6.1)	11 (5.6)	13 (6.6)	0.67
COVID-19 vaccination would negatively impact the effectiveness of SIV	21 (5.3)	10 (5.1)	11 (5.6)	0.82
Perceived Cons Scale score	8.5±1.8	8.5±1.7	8.6±1.9	0.33
Perceived self-efficacy related to SIV				
I am confident in receiving SIV (if I want to receive it)	378 (95.5)	185 (93.4)	193 (97.5)	0.054
Receiving SIV is easy for me	372 (93.9)	181 (92.4)	191 (96.5)	0.08
Perceived Self-efficacy Scale score	5.9±0.6	5.8±0.8	5.9±0.4	0.03
Stage of change related to SIV				0.12
Pre-contemplation stage	148 (37.4)	64 (32.3)	84 (42.4)	
Contemplation stage	87 (22.0)	48 (24.2)	39 (19.7)	
Preparation stage	161 (40.7)	86 (43.4)	75 (37.9)	

sample, a well-validated primary outcome, and a relatively low dropout rate.

Conclusion

A chatbot-delivered, stage-customised online intervention was more effective than a chatbot-delivered, non-stage-customised intervention in increasing SIV uptake among community-dwelling individuals aged ≥65 years.

Funding

This study was supported by the Health and Medical Research Fund, Health Bureau, Hong Kong SAR Government (#19181152). The full report is available from the Health and Medical Research Fund website (https://rfs2.healthbureau.gov.hk).

TABLE 2. Seasonal influenza vaccination (SIV) uptake within 6 months and behavioural intention to receive SIV in the next 6 months

Variable	Inter-vention	Control	Relative risk reduction (95% confidence interval)	P value	Absolute risk reduction (95% confidence interval)	Number needed to treat (95% confidence interval)	Adjusted odds ratios (95% confidence interval	P value
SIV uptake, %								
All participants	50.5	35.4	1.43 (1.13-1.80)	0.002	0.15 (0.06-0.25)	6.6 (4.0-18.1)	1.96 (1.30-2.94)	0.001
Those with no history of SIV at baseline	9.6	10.5	0.92 (0.36-2.34)	0.86	-0.01 (-0.10-0.08)	-114.1 (-9.8-11.8)	0.83 (0.28-2.40)	0.73
Those with a history of SIV at baseline	74.4	54.5	1.37 (1.12-1.67)	0.001	0.19 (0.08-0.32)	5.1 (3.1-12.6)	2.66 (1.52-4.67)	0.001
Behavioural intention to receive SIV in the next 6 months among those who had not received SIV, %	39.8	35.9	1.11 (0.79-1.55)	0.55	0.04 (-0.08-0.17)	25.9 (-11.2-6.0)	1.18 (0.68-2.04)	0.56

TABLE 3. Between-group differences in perceived pros and cons and self-efficacy, as well as stage of change, related to seasonal influenza vaccination uptake

Variable	Intervention group (n=198)	Control group (n=198)	Adjusted β	P value
Perceived Pros Scale score				
Baseline	7.5±1.7	7.4±1.8	0.02	0.76
Month 6	6.9±2.3	6.1±2.6	0.17	0.001
Month 6 - baseline	-0.6±2.4	-1.3±3.1	0.14	0.007
Perceived Cons Scale score				
Baseline	8.5±1.7	8.6±1.9	-0.07	0.14
Month 6	10.2±3.5	11.1±3.4	-0.15	0.002
Month 6 – baseline	1.7±3.3	2.5±3.3	-0.12	0.02
Perceived Self-efficacy Scale score				
Baseline	5.8±0.8	5.9±0.4	-0.11	0.03
Month 6	4.4±1.8	3.9±1.7	0.14	0.01
Month 6 – baseline	-1.4±1.8	-2.0±1.7	0.14	0.01
Stage of change				
Baseline	2.1±0.9	2.0±0.9	0.09	0.08
Month 6	2.8±1.3	2.3±1.3	0.17	0.001
Month 6 - baseline	0.7±1.0	0.3±1.0	0.13	0.01

Disclosure

The results of this research have been previously published in:

1. Wang Z, Chan PS, Fang Y, et al. Chatbot-delivered online intervention to promote seasonal influenza vaccination during the COVID-19 pandemic: a randomized clinical trial. JAMA Netw Open 2023;6:e2332568.

References

1. World Health Organization. Fact Sheets: Influenza (seasonal). Accessed 30 November 2022. Available from: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal).
2. Centre for Health Protection. Recommendation on Seasonal Influenza Vaccination for the 2018/19 season in Hong Kong. Accessed 30 November 2022. Available from: https://www.chp.gov.hk/files/pdf/scvpd_recommendations_on_siv_for_2018_19_season.pdf.
3. Centre for Health Protection. Seasonal influenza vaccination & pneumococcal vaccination. Accessed 30 November 2022. Available from: https://www.chp.gov.hk/files/pdf/1sivandpv.pdf.
4. The Government of the Hong Kong SAR. End of winter influenza season 2020. Accessed 30 November 2022. Available from: https://www.info.gov.hk/gia/general/202002/13/P2020021300600.htm.
5. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. Am J Health Promot 1997;12:38-48.