Title	**How do anticipated worry and regret predict seasonal influenza vaccination uptake among Chinese adults?**
Author(s)	**Liao, Q.; Wong, W. S.; Fielding, R.**
Citation	**Vaccine, 2013, v. 31, n. 38, p. 4084-4090**
Issued Date	**2013**
URL	**http://hdl.handle.net/10722/220880**
Rights	**NOTICE: this is the author's version of a work that was accepted for publication in Vaccine. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in Vaccine, 2013, v. 31 n. 38, p. 4084-4090. DOI: 10.1016/j.vaccine.2013.07.009**

How do anticipated worry and regret predict seasonal influenza vaccination uptake among Chinese adults?

Liao Q[a], Wong WS[b,1], Fielding R[a].

Affiliations:

[a] Health Behaviors Research Group, School of Public Health, The University of Hong Kong, 21 Sassoon Road, Pokfulam, Hong Kong, China.

[b] Department of Psychological Studies, Center for Psychosocial Health & Aging, Hong Kong, China

Correspondence to Wing Sze Wong:

Department of Psychological Studies, The Hong Kong Institute of Education, 10 Lo Ping Road, Tai Po, N. T., Hong Kong SAR.

Tel: +852 2948 8936; Fax: +852 2948 8454

Email: qyliao11@hku.hk (Q. Liao), wingwong@ied.edu.hk (W.S. Wong), fielding@hku.hk (R. Fielding)

Abstract

Objectives: To test two hypothesized models of how anticipated affect, cognitive risk estimate and vaccination intention might influence vaccination uptake against seasonal influenza.

Methods: The study collected baseline and follow-up data during the main influenza seasons (January-March) of 2009 and 2010, respectively, among 507 university students and staff of a university in Hong Kong. Following logistic regression to determine eligible variables, two mediation models of cognitive risk estimate, anticipated affect, vaccination intention and vaccination uptake against seasonal influenza were tested using structural equation modeling.

Results: Mediation analyses found that anticipated worry if not vaccinated influenced seasonal influenza vaccination uptake through its effects on either perceived probability of influenza infection (β=0.45) or intention (β=0.45) while anticipated regret if not vaccinated influenced vaccination uptake through its effect on intention (β=0.45) only; anticipated regret if vaccinated impeded vaccination uptake indirectly through its effect on vaccination intention (β=-0.26) or directly (β=-0.20); perceived probability of influenza infection influenced vaccination uptake through its effect on intention (β=0.20) or directly (β=0.22); and finally, intention influenced vaccination uptake directly (β=0.58).

Conclusion: The results suggest that anticipated affect seems to drive risk estimates related to seasonal influenza vaccination rather than vice versa and intention remains an important mediator of the associations of anticipated affect and cognitive risk estimate with vaccination uptake against seasonal influenza.

Key words: influenza; vaccination uptake; affect; risk; Chinese

Introduction

Vaccination uptake against seasonal influenza remains low for both priority groups and healthy population worldwide [1-5]. Perceived risk of influenza, mostly conceptualized as cognitive risk estimates such as perceived likelihood/probability of contracting infection (perceived susceptibility) and perceived severity of the infection, has been considered crucial for decision-making on vaccination uptake [6]. Perceived susceptibility and perceived severity are core components of cognitive behavioral models such as the Health Belief Model and Protection Motivation Theory for predicting health behavioral change [7, 8]. However, cognitive behavioral models have been frequently criticized for treating human beings as emotionless and failing to accommodate the influence of affect [9]. More recent studies address cognitive-affective dual processing influences in decisions about health protective behaviors [10, 11]. The affect-loaded constructs, worry and regret, have received most scrutiny. These concepts reflect primarily ruminative processes that have a strong negative affective overlay. Worry and regret were found to be strongly associated with both vaccination intention or vaccination uptake [12-18]. Some data suggest that anticipated worry and anticipated regret (anticipated affect), are better predictors than cognitive risk estimates in predicting vaccination uptake [13-15]. In correlational studies, anticipated affect, rather than the actually experienced affect at the time of decision (immediate affect), partly mediated the effects of cognitive risk estimate on subsequent influenza vaccination uptake [13]. However, empirical studies seldom indicate how the anticipation of affective activation might cause reported behavioral change. Do heightened risk estimates generate higher anticipated affect thereby motivating individuals to act? Or, alternatively does greater anticipated affect causes heightened risk estimates which instead motivates action? The risk-as-feeling hypothesis proposes that anticipated affect predicts cognitive risk estimate and the current affect both of which predict behavioral change, providing theoretical support for the alternative explanation [19].

Intention is considered the most proximal and therefore strongest predictor of actual behavioral change in existing cognitive behavioral theories [9]. However, previous mediation analyses did not includ

vaccination intention as the mediator for the relationship between cognitive risk estimate/anticipated affect and actual vaccination uptake in the mediation model [13]. Therefore, it remains unknown how much cognitive risk estimate/anticipated affect influences vaccination uptake directly, versus indirectly by modifying intention, or both. Previous studies used anticipated regret as an important component of the extended version of Theory of Planned Behavior to predict intention to receive influenza vaccine [12, 17, 20, 21], suggesting that intention is considered important for bridging anticipated affect and actual behavioral change. In one recent study, anticipated affect remained a strong predictor of vaccination uptake even after controlling for vaccination intention, suggesting a direct effect of anticipated affect on vaccination uptake [15]. Traditionally, researchers test simple mediation models which include only a single mediator though several potential mediators may be available [22]. This is possibly due to arcane analytic methods for simultaneous tests of multiple mediators in a single model. Recent applications of structural equation modeling (SEM) enable optimal simultaneous estimation of multiple mediators through greater flexibility in model specification and estimation [22]. Apart from testing more complex mediation models, SEM also provides model fit indices which can indicate potential causal associations even with only correlational data [23]. Obtaining a more comprehensive picture of the role anticipated affect plays in predicting vaccination uptake requires the inclusion of vaccination intention in the mediation analysis and tests of the mediation model using SEM.

Building on previous work [13] we conducted a two-wave longitudinal study to understand the role of anticipated affect (worry and regret) in predicting seasonal influenza vaccination uptake in Hong Kong Chinese adults. Fig. 1 depicts the conceptual framework for the mediation relationships. Two exclusive hypotheses were made for the relationships between cognitive risk estimate and anticipated affect, represented in two hypothesized models: Model *I* adopted Path I , reflecting anticipated affect mediating the associations of cognitive risk estimate with both vaccination intention and subsequent vaccination uptake; Model *II* adopted Path II an alternative formulation where cognitive risk estimate mediates the associations of anticipated affect with vaccination intention and subsequent vaccination uptake. In both

models, intention was hypothesized to mediate the associations of anticipated affect and cognitive risk estimate with vaccination uptake (Fig. 1). The objectives of this study was to disentangle the relationships among cognitive risk estimate, anticipated affect, seasonal influenza vaccination intention and vaccination uptake with SEM by testing these two hypothesized models (Fig. 1).

Methods

Procedure and participants

The major influenza season usually extends from January to March in Hong Kong [24]. Annual seasonal influenza vaccination campaign is held around October or November to encourage individuals to take the vaccine before the onset of the major influenza season. This study was conducted during the major influenza season in Hong Kong with the baseline data collected in January-March 2009 and with follow-up data collected in January-March 2010

Following ethics approval from the Institutional Review Board of the City University of Hong Kong (CityU), an email inviting participation in the study was sent out to a random sample of students, faculty and staff drawn from the list of email addresses of CityU during the data collection periods. Participants who were willing to participate in the survey could click the hyperlink connecting to the web questionnaire in the email and complete the online questionnaire. Weekly reminders were sent to target participants who had not yet participated in the study to improve response rate.

Measures

The questionnaire content was based on previous studies [13, 14] and pre-tested for translation accuracy, acceptability, and comprehensibility before being uploaded to the university intranet website. The baseline and follow-up surveys collected similar data that mainly focused on risk perception (both cognitive and cognitive-affective), vaccination intention and vaccination uptake regarding seasonal influenza. However, unexpectedly the 2009 influenza A/H1N1 pandemic began in June 2009, extending

till November 2009 in Hong Kong [25]. Therefore, in the follow-up survey, 21 new items on perceptions and vaccination related to A/H1N1 were also included in the questionnaire but were excluded in the current analysis. This study obtained data of anticipated affect, cognitive risk estimate, vaccination intention and demographic data from the baseline survey and vaccination uptake against seasonal influenza from the follow-up survey. Details of the measures for this study are described below.

Anticipated affect: Paired items assessed anticipated worry and anticipated regret, respectively. For anticipated worry, item pairs were framed for either being or not being vaccinated against seasonal influenza. Specifically, respondents were asked "How much worry would you feel about contracting flu during the coming year *if you were (were not) to get the flu shot*?" For anticipated regret another item pair were framed for either being or not being vaccinated against seasonal influenza then subsequently developing influenza in the coming year. Respondents were asked "How much regret you would feel during the coming year *if you were (were not) to get the flu shot* and subsequently get the flu?" Responses for these four items were four-point categorical options ranging from "1=no worry/regret at all" to "4=extreme worry/regret".

Cognitive risk estimates Cognitive risk estimates comprised assessment of perceived probability and perceived severity of influenza infection. A seven-point categorical scale was used for measuring respondents' estimate of the risk probability of influenza infection if not vaccinated. Specifically, respondents were asked to indicate the probability (from "1=almost zero" to "7=almost certain") in response to the statement: "If I don't get the ‘flu shot, I think my chances of getting flu next year would be ...". Respondents were also asked to estimate the severity of that influenza infection by responding to "How much would the illness interfere with your daily activities (e.g., work, school, or housework) if you got flu this year?". Response options for this question were on an 11-point ordinal scale of severity from "0=no interference" to "10=unable to carry on any activity".

Vaccination intention Respondents were asked how likely it was that they would undergo vaccination against seasonal influenza in the coming 12 months; responses ranged from "1=extremely likely" to "6=very unlikely". For subsequent analysis this score was re-coded so that higher values indicated greater intention to vaccinate.

Except for the above variables, respondents' demographic details including age, gender, marital status, occupation (employee/student) education attainment, and prior seasonal influenza vaccination history (Yes/No) were also obtained from the baseline survey.

Vaccination uptake Vaccination uptake against seasonal influenza was obtained from the follow-up survey. Respondents were asked whether they had received at least one dose of influenza vaccine during the preceding 12 months (Yes/No).

Data analysis

Demographic differences between respondents who completed both waves of the survey and those lost to follow-up, and between those who received influenza vaccine in the follow-up and those who did not were tested with Pearson Chi-square test. The hypothesized mediation associations (Fig. 1) were first tested based on the several criteria for mediation popularized by Baron and Kenny [26] that the independent variable, mediator and outcome variable are significantly correlated and the initial effect of the independent variable on the outcome variable is substantially reduced after controlling for the mediator. Specifically, zero-order correlations between cognitive risk estimate, anticipated affect, vaccination intention and vaccination uptake were first calculated. Then, a series of multivariate logistic regression was performed to examine (1) the initial effect of each variable of cognitive risk estimate, anticipated affect and vaccination intention on vaccination uptake, (2) whether including cognitive risk estimate and anticipated affect simultaneously in the regression model could substantially reduce the initial effect of each individual variable or not, and (3) whether the effects of cognitive risk estimate and

anticipated affect could be substantially reduced after including intention as an additional predictor in the model. All logistic regression models were adjusted for significant demographics and past seasonal influenza vaccination, a known predictor of perceptions, vaccination intention and vaccination uptake [13, 15, 27] thereby a potential confounder influencing the relationships (Fig. 1) under examination. If relative mediation emerged [26], the hypothesized mediation models were further tested using Mplus software with SEM [28]. To test the model, all variables for the mediation model were entered into the SEM simultaneously. Standardized parameters (β) for each path in the model were assessed with mean and variance adjusted weighed least squares estimation. The fit of the model was evaluated with several model fit indices provided in Mplus, where the Comparative Fit Index (CFI) >0.90, Tucker Lewis Index (TLI) >0.90 and Root Mean Square Error of Approximation (RMSEA) <0.05 indicate good model fit to the data [23]. All statistics with a p-value <0.05 were considered significant.

Results

Participants

By the end of March 2009 over the 12-week data collection period, 1761 participants had completed the baseline survey (~35% of the 5000 invited employees and students of CityU), of which, 525 (30%, 525/1761) completed the follow-up survey at the end of March 2010. Compared to those completed the follow-up surveys, respondents lost to follow-up were only slightly younger (Table 1). Around 14% of the 525 respondents reported having had been vaccinated against influenza in the follow-up survey. Vaccination status at follow-up significantly differed by age, marital status, occupation, past influenza vaccination and baseline vaccination intention (Table 1). Of the 525 respondents who completed the follow-up survey, 18 (3%) reported they had received A/H1N1 vaccine. These subjects were excluded to minimize potential influence of A/H1N1 vaccination on uptake of seasonal influenza vaccination, leaving 507 subjects for the following analysis.

Correlations of cognitive risk estimate, anticipated affect, vaccination intention and vaccination uptake

All variables of cognitive risk estimates and anticipated affect were positively associated with vaccination intention and vaccination uptake except that anticipated regret if vaccinated was negatively associated with vaccination intention and vaccination uptake and that anticipated worry if vaccinated was not significantly associated with vaccination uptake; cognitive risk estimate and anticipated affect variables were positively correlated except for anticipated regret if vaccinated (Table 2).

Regression analyses

Models 1-7 showed that after adjusting for significant demographics and past flu vaccination, all cognitive risk estimate, anticipated affect and vaccination intention variables remained significant predictors of subsequent vaccination uptake, except for perceived severity of influenza and anticipated worry if vaccinated which were therefore excluded from subsequent regression analysis (Table 3). When perceived probability of infection and anticipated affect were included simultaneously in the regression model (Model 8), the initial effect of each individual variable on vaccination uptake were substantially reduced except for anticipated regret if vaccinated, but all remained significant (Table 3). Finally, in Model 9 after vaccination intention was additionally included, the effects of perceived probability of infection and anticipated affect on vaccination uptake became non-significant though small effects on vaccination uptake from perceived probability of infection and anticipated regret if vaccinated still existed (Table 3).

The SEM analyses

Based on the results of the above analyses and the conceptual framework (Fig. 1), the following two hypothesized models were tested: Model *I*, anticipated worry and regret if not vaccinated partially mediate the effect of perceived probability of infection on vaccination intention; Model *II*, perceived probability of infection partially mediated the effects of anticipated worry and regret if not vaccinated on vaccination intention; and in both models intention was hypothesized to partially mediate the effects of

perceived probability of infection and anticipated regret if vaccinated and completely mediate the effects of anticipated worry and anticipated regret if not vaccinated on vaccination uptake.

Using SEM, Model *I* resulted in a poor fit to the data, with CFI=0.888, TLI=0.686 and RMSEA=0.157 (Fig. 2), suggesting that this mediation model was mis-specified. In contrast, Model *II* showed a good fit with CFI=0.996, TLI=0.983 and RMSEA=0.036. Further removing a non-significant path from anticipated regret if not vaccinated to perceived probability of infection (β=0.05, p=0.140) did not degrade the model fit indices (CFI=0.994, TLI=0.981 and RMSEA=0.038) and produced a more parsimonious model (The modified Model *II* in Fig.2). The SEM analysis suggests that the mediation relationships specified in the modified version of Model *II* were supported. The modified Model *II* showed that anticipated worry if not vaccinated affected vaccination uptake by influencing perceived probability of infection (β=0.45) and vaccination intention (β=0.22); anticipated regret if not vaccinated affected vaccination uptake only by influencing vaccination intention (β=0.32); anticipated regret if vaccinated affected vaccination uptake either indirectly through its negative effect on vaccination intention (β=-0.26) or directly (β=-0.20); perceived probability of infection affected vaccination uptake either indirectly through its effect on vaccination intention (β=0.20) or directly (β=0.22); vaccination intention affected vaccination uptake directly (β =0.58); finally, this model explained a total of 56.0% variance in vaccination uptake against seasonal influenza (Fig. 2).

Discussion

These findings reflect the influences of anticipated affect on seasonal influenza vaccination uptake in this Chinese sample. Previous studies of anticipated reductions in (negative) affective states (emotional benefits) from influenza vaccination reported that the anticipation of more emotional benefits from vaccination drove subsequent influenza vaccination uptake [13, 15]. However, in our sample, while anticipated worry if not vaccinated significantly predicted vaccination uptake, anticipated worry if vaccinated did not seem to negatively predict vaccination uptake, probably because this scenario is highly

unlikely. Respondents in this study generally anticipated more regret following vaccination than when not vaccinated, which is inconsistent with reports based on western samples [13], suggesting omission bias might influence vaccination uptake among Chinese. Omission bias refers to greater anticipated regret for the consequence of action rather than inaction, and is an important barrier to vaccination uptake [18, 29, 30].

The mediation analyses suggest that cognitive risk estimate can partially mediate the association between anticipated worry and vaccination uptake. Intention totally mediated the associations of anticipated worry and regret if not vaccinated with vaccination uptake but only partially mediated the associations of anticipated regret if vaccinated and perceived probability of infection with vaccination uptake.

Previous studies proposed that anticipated affect mediated the association between cognitive risk estimate and vaccination uptake [13]. Our study suggests a different mechanism: that anticipating more worry about not being vaccinated leads to higher risk probability estimate, which in turn motivates people to take vaccination. Controversy remains over whether affect precedes cognitive appraisal or vice versa or if the two are interactive [31]. Affect functions as if it were primarily a motivation-signaling system. There is a distinction between anticipated affect and affect actually experienced. Anticipated affect is the prediction of future affective states resulting from a particular decision [31]. This requires simulations of future internal states, but like all models they only offer a probability approximation at the time of decision of what will actually be experienced and may serve to provide primitive motivational guidance under conditions of cognitive uncertainty [31, 32]. Hence, it makes sense that anticipated affect rather than the concurrent affect informs cognitive evaluations of future risk.

However, anticipated regret did not influence vaccination uptake through cognitive risk estimate. Unlike worry, regret does not reflect threat, but rather seems to be a secondary affective state generated along with self-blame, which might be thought of as a means of signaling an incorrect decision [33].

Anticipated regret simulates future negative feeling states that could be avoided if different action is (or is not) undertaken. Therefore, anticipated regret is unlikely to influence the probability of risk estimate but instead strongly influence intention to act. This is consistent with previous studies that report strong associations between anticipated regret and vaccination intention [12, 17, 34, 21, 20]. Previous studies combined anticipated regret for inaction and anticipated regret for action into one single scale (anticipated regret reduction) [13]. Our data showed the internal consistency of these two items to be very low, with anticipated regret for being vaccinated reversed coded, suggesting that these two items measure different constructs that influence behavioral change differently and thus it is inappropriate to combine them into one construct. Our model showed that while anticipated regret if not vaccinated was positively associated with vaccination intention, in addition to reducing vaccination uptake indirectly by reducing vaccination intention, anticipated regret if vaccinated also directly impeded vaccination uptake. Vaccination intention mediated the associations of both cognitive risk estimate and anticipated affect with vaccination uptake, and remained the strongest predictor for subsequent vaccination uptake though there remains a large intention-behavior gap [35-37], which may be attributable to planning differences [21]. This mediation model finally explained a total of 56.0% of variance in vaccination uptake, which is significantly superior to other cognitive models such as the Theory of Planned Behavior, which typically accounts for only around 35% of variance [38, 39].

This study had several limitations. First, the response rate in the follow-up survey was low though subjects lost to follow-up were only slightly younger. This suggests that students dropped out of the follow-up survey because of graduation leading to a slight increase in respondent mean age at follow-up. We had adjusted for age in the regression models to reduce the influence of age on the associations we examined. Second, respondents were either university students or staff, most relatively well-educated members of the community so findings may not generalize to the wider Hong Kong population. Third, the influenza A/H1N1 pandemic of 2009 may inadvertently have influenced the study results. The A/H1N1 epidemic in Hong Kong lasted from June 2009 to November 2009 [25]. A/H1N1 vaccine was available

for at-risk populations such as the elderly and healthcare workers, from late December 2009 and for the general public from late January 2010 [21]. Hence data collection in Wave 2 may be influenced by both the outbreak of and the vaccination campaign against A/H1N1. However, in this analysis data on anticipated affect, cognitive risk perception, and vaccination intention were obtained during Wave 1, prior to the emergence of A/H1N1, and thereby the associations between these variables were not affected by the subsequent A/H1N1 outbreak. The only data obtained from Wave 2 for this analysis was the vaccination uptake against seasonal influenza. It is possible that people may have sought seasonal influenza vaccination to avoid A/H1N1 influenza infection [40] though A/H1N1 was emphatically an entirely novel influenza strain compared to the circulating seasonal influenza types [41]. Additionally, since seasonal influenza vaccination uptake was self-reported, subjects who had received A/H1N1 vaccine but not seasonal influenza vaccine may have been wrongly classified as having received seasonal influenza vaccine if they could not distinguish the two types of influenza vaccines. We excluded the small number (N=18) of subjects who reported having had received A/H1N1 vaccine to minimize the influence of this mis-classification. However, we expect that if these two scenarios did occur, the current positive associations of seasonal influenza vaccination uptake with anticipated affect, cognitive risk estimate and vaccination intention would be underestimated. Given vaccination uptake against A/H1N1 was extremely low in Hong Kong [21], therefore, any influence of A/H1N1 vaccination uptake on our study results is likely to have been limited. Finally, mediation analysis is mainly based on correlational data and therefore casual associations cannot be confirmed. Nevertheless, the excellent model fit indices provided by SEM and the high level of explained variance in seasonal vaccination uptake together provide strong support for potential casual associations between these variables.

Conclusion

Our mediation analyses using SEM suggest that anticipated affect could drive vaccination uptake through promoting cognitive risk estimate and vaccination intention. Anticipated regret about being vaccinated, being closely related to omission bias, could even hinder subsequent vaccination uptake directly.

Intention remains to be an important mediator of the associations of anticipated affect and cognitive risk estimate with vaccination uptake.

(Word count:3,533)

Acknowledgement

This study was supported by a Strategic Grant from City University of Hong Kong (Grant no.: 7008008) awarded to the corresponding author (Dr. W. S. Wong).

References

[1] Lau JT, Yang X, Tsui HY, Kim JH. Prevalence of influenza vaccination and associated factors among community-dwelling Hong Kong residents of age 65 or above. Vaccine 2006;24(26):5526-34.

[2] Mok E, Yeung SH, Chan MF. Prevalence of influenza vaccination and correlates of intention to be vaccinated among Hong Kong Chinese. Public Health Nurs 2006;23(6):506-15.

[3] Kee SY, Lee JS, Cheong HJ, Chun BC, Song JY, Choi WS et al. Influenza vaccine coverage rates and perceptions on vaccination in South Korea. J Infect 2007;55(3):273-81.

[4] Takayama M, Wetmore CM, Mokdad AH. Characteristics associated with the uptake of influenza vaccination among adults in the United States. Prev Med 2012;54(5):358-62.

[5] Blank PR, Schwenkglenks M, Szucs TD. Influenza vaccination coverage rates in five European countries during season 2006/07 and trends over six consecutive seasons. BMC Public Health 2008;8:272.

[6] Brewer NT, Chapman GB, Gibbons FX, Gerrard M, McCaul KD. Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. Health Psychol 2007;26(2):136-45.

[7] Carpenter CJ. A meta-analysis of the effectiveness of health belief model variables in predicting behavior. Health Commun 2010;25(8):661-9.

[8] Floyd DL, Prentice-Dunn S, Rogers RW. A meta-analysis of research on protection motivation theory. J Appl Soc Psychol 2000;30:407-29.

[9] Conner M, Norman P. Predicting health behavior. Berkshire: Open University Press; 2005.

[10] Slovic P, Finucane ML, Peters E, MacGregor DG. Risk as analysis and risk as feelings: some thoughts about affect, reason, risk, and rationality. Risk Anal 2004;24(2):311-22.

[11] Renner B, Reuter T. Predicting vaccination using numerical and affective risk perceptions: the case of A/H1N1 influenza. Vaccine 2012;30(49):7019-26.

[12] Gallagher S, Povey R. Determinants of older adults' intentions to vaccinate against influenza: a theoretical application. J Public Health (Oxf) 2006;28(2):139-44.

[13] Chapman GB, Coups EJ. Emotions and preventive health behavior: worry, regret, and influenza vaccination. Health Psychol 2006;25(1):82-90.

[14] Weinstein ND, Kwitel A, McCaul KD, Magnan RE, Gerrard M, Gibbons FX. Risk perceptions: assessment and relationship to influenza vaccination. Health Psychol 2007;26(2):146-51.

[15] Thompson MG, Gaglani MJ, Naleway A, Ball S, Henkle EM, Sokolow LZ et al. The expected emotional benefits of influenza vaccination strongly affect pre-season intentions and subsequent vaccination among healthcare personnel. Vaccine 2012;30(24):3557-65.

[16] Bish A, Yardley L, Nicoll A, Michie S. Factors associated with uptake of vaccination against pandemic influenza: a systematic review. Vaccine 2011;29(38):6472-84.

[17] Godin G, Vezina-Im LA, Naccache H. Determinants of influenza vaccination among healthcare workers. Infect Control Hosp Epidemiol 2010;31(7):689-93.

[18] Asch DA, Baron J, Hershey JC, Kunreuther H, Meszaros J, Ritov I et al. Omission bias and pertussis vaccination. Med Decis Making 1994;14(2):118-23.

[19] Loewenstein GF, Weber EU, Hsee CK, Welch N. Risk as feelings. Psychol Bull 2001;127(2):267-86.

[20] Myers LB, Goodwin R. Determinants of adults' intention to vaccinate against pandemic swine flu. BMC Public Health 2011;11(1):15.

[21] Liao Q, Cowling BJ, Lam WW, Fielding R. Factors affecting intention to receive and self-reported receipt of 2009 pandemic (H1N1) vaccine in Hong Kong: a longitudinal study. PLoS ONE 2011;6(3):e17713.

[22] Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav Res Methods 2008;40(3):879-91.

[23] Kline RB. Principles and practice of structural equation modeling. New York: Guiford; 2005.

[24] Center for Health Protection Hong Kong. Communicable diseases watch. 2011; http://www.chp.gov.hk/en/epidemiology/441/112/578.html.

[25] Cowling BJ, Ng DM, Ip DK, Liao Q, Lam WW, Wu JT et al. Community psychological and behavioral responses through the first wave of the 2009 influenza A(H1N1) pandemic in Hong Kong. J Infect Dis 2010;202(6):867-76.

[26] Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol 1986;51(6):1173-82.

[27] Chapman GB, Coups EJ. Predictors of influenza vaccine acceptance among healthy adults. Prev Med 1999;29(4):249-62.

[28] Muthén LK, Muthén BO. Mplus User's Guide. Sixth ed. Los Angeles, CA: Muthén & Muthén; 1998-2010.

[29] Brown KF, Kroll JS, Hudson MJ, Ramsay M, Green J, Vincent CA et al. Omission bias and vaccine rejection by parents of healthy children: implications for the influenza A/H1N1 vaccination programme. Vaccine 2010;28(25):4181-5.

[30] Dibonaventura M, Chapman GB. Do decision biases predict bad decisions? Omission bias, naturalness bias, and influenza vaccination. Med Decis Making 2008;28(4):532-9.

[31] Chang LJ, Sanfey AG. Emotion, decision-making and the brain. Adv Health Econ Health Serv Res 2008;20:31-53.

[32] Slovic P, Finucane ML, Peters E, MacGregor DG. The affect heuristic. In: Gilovich T, Griffin D, Kahneman D, editors. Intuitive judgment: heuristics and biases. New York: Cambridge University Press; 2002. p. 397-420.

[33] Gilbert DT, Morewedge CK, Risen JL, Wilson TD. Looking forward to looking backward: the misprediction of regret. Psychol Sci 2004;15(5):346-50.

[34] Sheeran P, Orbell S. Augmenting the theory of planned behavior: roles for anticipated regret and descriptive norms. Journal of Applied Social Psychology 1999;29(10):2107-42.

[35] Harris KM, Maurer J, Lurie N. Do people who intend to get a flu shot actually get one? J Gen Intern Med 2009;24(12):1311-3.

410 [36] Sheeran P. Intention-behavior relations: a conceptual and empirical review. In: Stroege W, Hewstone
411 M, editors. European review of social psychology. London: Wiley; 2002. p. 1-36.
412 [37] Webb TL, Sheeran P. Does changing behavioral intentions engender behavior change? A meta-
413 analysis of the experimental evidence. Psychol Bull 2006;132(2):249-68.
414 [38] Godin G, Kok G. The theory of planned behavior: a review of its applications to health-related
415 behaviors. Am J Health Promot 1996;11(2):87-98.
416 [39] Armitage CJ, Conner M. Efficacy of the theory of planned behaviour: a meta-analytic review. Br J
417 Soc Psychol 2001;40(Pt 4):471-99.
418 [40] Opstelten W, van Essen GA, Heijnen ML, Ballieux MJ, Goudswaard AN. High vaccination rates for
419 seasonal and pandemic (A/H1N1) influenza among healthcare workers in Dutch general practice. Vaccine
420 2010;28(38):6164-8.
421 [41] World Health Organization. World now at the start of 2009 influenza pandemic. Statement to the
422 press by WHO Director-General Dr Margaret Chan. 2009;
423 http://www.who.int/mediacentre/news/statements/2009/h1n1_pandemic_phase6_20090611/en/index.html.
424
425
426

FIGURE LEGEND

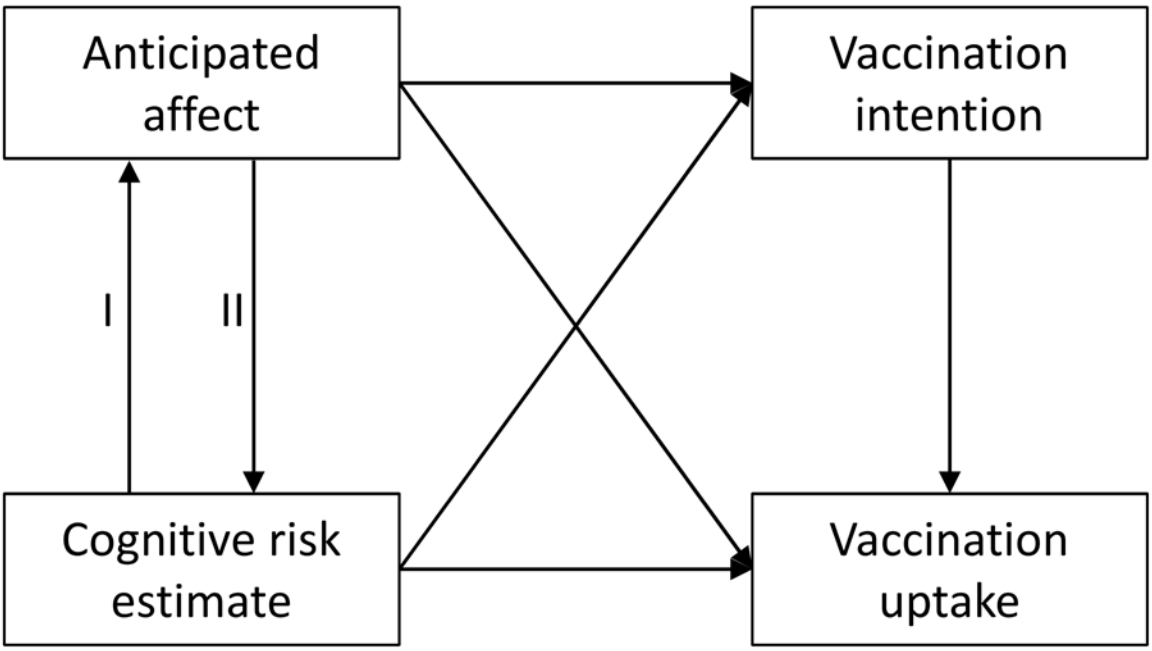

Fig. 1 Conceptual model for the mediation relationships between anticipated affect, cognitive risk estimate, vaccination intention and vaccination uptake.

Path I and Path II specified in the above diagram represent the two exclusive hypotheses reflected in Model *I* (Path I - cognitive risk estimate influences anticipated affect) and Model *II* (Path II anticipated affect influences cognitive risk estimate)

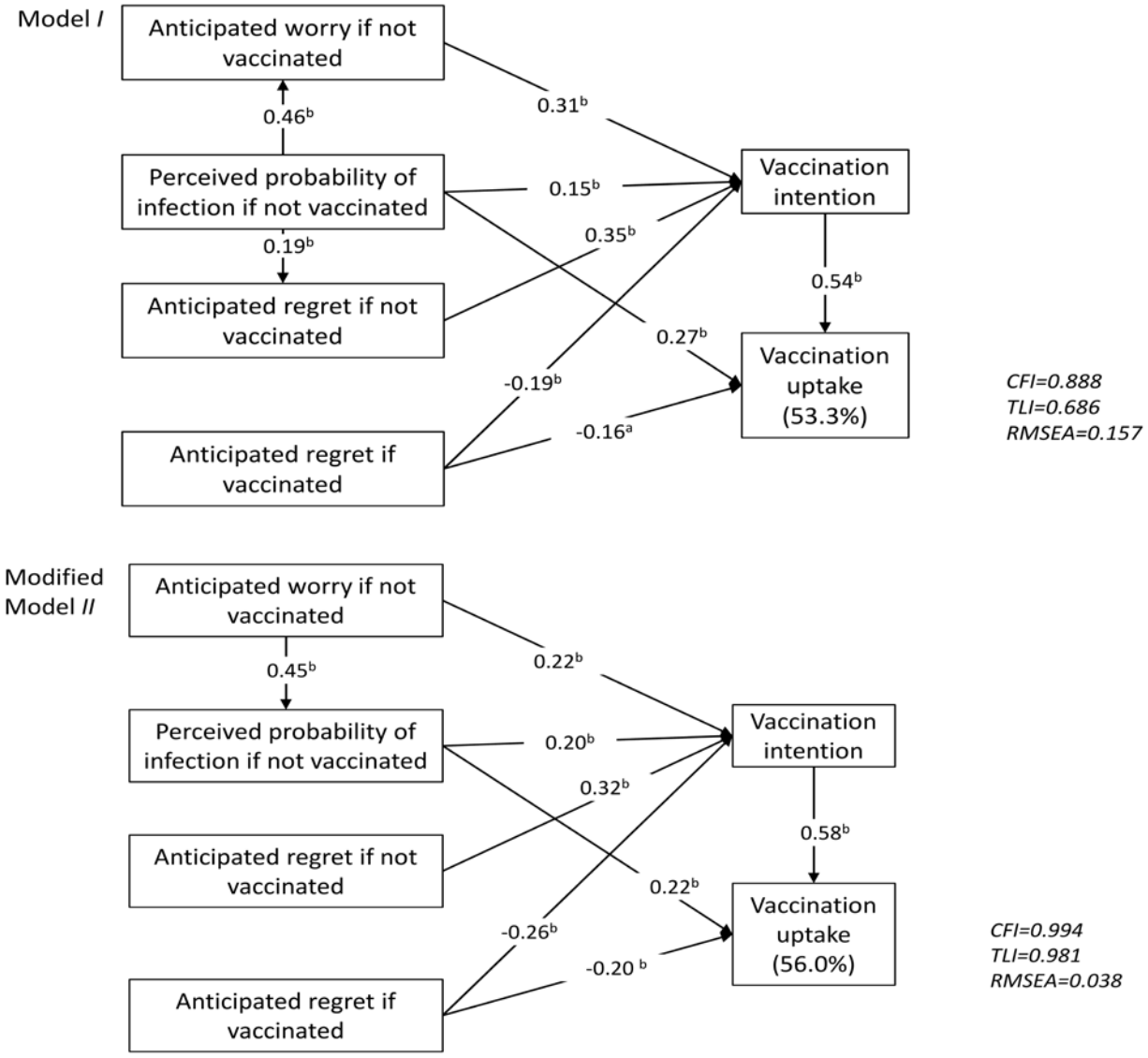

Fig. 2 Mediation analysis with Structural Equation Modeling for the relationship between anticipated affect, cognitive risk estimate, vaccination intention and vaccination uptake.

Note: All numbers in the paths represent standardized path coefficients. The percentage shown in the vaccination uptake indicates the explained variances in vaccination uptake by the model. The Modified Model *II* was a revised version of the original Model *II* by removing a non-significant path from anticipated regret for not taking vaccine to perceived probability of infection; [a] $p<0.05$, [b] $p<0.001$; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Square Error of Approximation

Table 1 Comparison of participants who completed and did not complete the follow-up survey, and who were and were not vaccinated by the time of the follow-up survey by their baseline demographics, vaccination history and vaccination intention.

Variables	Lost to follow (N=1239)	Completed the follow-up surveys (N=525)	Vaccinated (N=74)	Not vaccinated (N=451)	Differences (p) [a]
Female	62%	60%	57%	61%	0.479 (0.515)
Aged ≥35 years	13%	18%	38%	14%	0.025 (<0.001)
Single	83%	82%	68%	84%	0.541 (<0.001)
Student (vs. employee)	68%	65%	46%	68%	0.199 (<0.001)
Education: ≥Tertiary	76%	77%	69%	78%	0.560 (0.085)
Past flu vaccination (yes)	38%	37%	70%	31%	0.697 (<0.001)
Vaccination intention (somewhat/very/extremely likely)	43%	41%	82%	34%	0.296 (<0.001)

[a] p-Value outside the parentheses indicates the differences between respondents who completed the follow-up survey and those lost to follow while p-value inside the parentheses indicates the differences between respondents were and were not vaccinated in the follow-up. All p-values were from Pearson Chi-square test.

Table 2 Correlation matrix between vaccination uptake, cognitive risk estimate, anticipated affect and vaccination intention (N=507) [a]

Variables	Range [b]	Mean (SD)[c]	1	2	3	4	5	6	7	8
1.Vaccination uptake	0-1	14%	1							
2. Perceived probability of infection	1-7	3.63 (1.18)	0.33[f]	1						
3. Perceived severity of infection	0-10	5.86 (2.02)	0.10[d]	0.24[f]	1					
4. Anticipated worry if not vaccinated	1-4	1.79 (0.70)	0.26[f]	0.46[f]	0.28[f]	1				
5. Anticipated worry if vaccinated	1-4	1.70 (0.74)	0.03	0.26[f]	0.12[e]	0.53[f]	1			
6. Anticipated regret if not vaccinated	1-4	1.70 (0.81)	0.21[f]	0.18[f]	0.23[f]	0.33[f]	0.06	1		
7. Anticipated regret if vaccinated	1-4	1.98 (1.02)	-0.16[f]	-0.03	0.08	0.06	0.19[f]	0.11[d]	1	
8. Vaccination intention	1-6	2.93 (1.37)	0.50[f]	0.36[f]	0.21[f]	0.40[f]	0.15[f]	0.38[f]	-0.21[f]	1

[a] Subjects who reported having had received A/H1N1 vaccine (N=18) were excluded from the analysis.

[b] Range of the response scale of each variable.

[c] Mean and Standard Deviation (SD) for each variable were presented except for vaccination uptake of which percentage was given.

[d] $p<0.05$.

[e] $p<0.01$.

[f] $p<0.001$.

Table 3 Logistic regression of follow-up vaccination uptake on cognitive risk estimate, anticipated affect and vaccination intention (N=507).

Predictors	Coefficient (standard errors)
Model 1: Perceived probability of infection	0.74 (0.14)[c]
Model 2: Perceived severity of infection	0.13 (0.08)
Model 3: Anticipated worry if not vaccinated	0.99 (0.21)[c]
Model 4: Anticipated worry if vaccinated	0.14 (0.20)
Model 5: Anticipated regret if not vaccinated	0.58 (0.17)[c]
Model 6: Anticipated regret if vaccinated	-0.45 (0.18)[a]
Model 7: Vaccination intention	1.41 (0.19) [c]
Model 8:	
Perceived probability of infection	0.53 (0.16) [b]
Anticipated worry if not vaccinated	0.59 (0.26) [a]
Anticipated regret if not vaccinated	0.38 (0.20) [a]
Anticipated regret if vaccinated	-0.62 (0.21) [c]
Model 9:	
Perceived probability of infection	0.30 (0.21)
Anticipated worry if not vaccinated	0.09 (0.31)
Anticipated regret if not vaccinated	0.01 (0.23)
Anticipated regret if vaccinated	-0.28 (0.23)
Vaccination intention	1.21 (0.21) [c]

Note: All regression models were controlled for significant demographic differences including age, marital status, occupation and past flu vaccination history; Perceived severity of influenza infection and anticipated worry if vaccinated were not included in Model 8 and Model 9 because they were not significantly associated with vaccination uptake after controlling for significant demographic differences and past flu vaccination history.

[a] $p<0.05$.

[b] $p<0.01$.

[c] $p<0.001$.