What influences the influenza vaccination rate of Canadians?

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Major Paper presented to the

Department of Economics of the University of Ottawa

in partial fulfillment of the requirements of the M.A. Degree

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Ottawa Ontario

August 2014

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Abstract

Influenza is a common disease not just in Canada but also worldwide that can cause serious health complications. Using data from the 2012 Canadian Community Health Survey (CCHS) data set, this paper explores the individual determinants of the decision to get an influenza vaccination. After dividing the sample into three age groups (young, middle-aged and seniors) and estimating logit models for each age group, this paper finds that being female, having a regular doctor and having certain chronic conditions are positively related to the probability of getting a flu shot for these three age groups. Smoking, living in Newfoundland and Labrador and living in Quebec are negatively related to the probability of influenza vaccination. Also, seniors have higher influenza vaccination rates compared to middle-aged and younger adults.

1. Introduction

In Canada, influenza is a common seasonal disease with the potential to spread widely. The influenza season usually runs from November to April (Flightflu.ca 2013), or during late autumn and winter. The long and cold winter in Canada provides good conditions for the flu virus to survive. About 5% to 15% of Canadians are affected by influenza annually (Polisena et al., 2012). Influenza can cause serious symptoms, such as cough, sore throat and severe headache, which can disturb people's daily lives. What's worse, high risk people may develop complications after they get influenza, such as, pneumonia, bronchitis, sinus infections or ear infections. The complications may be more dangerous than the influenza itself. Each year, approximately 20,000 hospital admissions and between 2,000 and 8,000 deaths in Canada are due to influenza complications (Polisena et al., 2012).

Influenza is a global health issue, with widespread cases in Europe, North America and Asia and resulting deaths every year. Also, the types of influenza virus (e.g., H1N1 avian flu) that are the most prevalent change from season to season and from year to year. Thus, influenza attracts lots of public attention. Since influenza vaccination is one of the most effective ways to reduce the impact and contraction rate of seasonal flu, a study of influenza vaccination uptake could yield useful suggestions to governments and policy makers.

In Canada, each provincial government specifies its own policy rules regarding influenza vaccination programs. Table 1 provides a summary of the policies for each province. Ontario, Alberta, Nova Scotia, Manitoba, Saskatchewan, Yukon/Northwest Territories/Nunavut and Prince Edward Island provide free influenza vaccination to all residents aged over 6 months. On the other hand, Quebec, New Brunswick, Newfoundland and Labrador and British

Columbia charge a fee for influenza vaccinations depending on an individual's health risk. In these four provinces flu shots are offered for free only to high-risk groups.[1] For example, people with chronic health conditions, seniors, pregnant women and people in close contact with high-risk people can get free flu shots in these four provinces. A fee is charged for non-high-risk groups to get vaccinated. All these provincial governments strongly advise people who are at higher risk of flu complications to get a flu shot.

According to PHAC (2014a), the vaccination take-up rate among adults in 2008 was 35.8%. In 2010 the rate fell to 28.1%, but then rose to 37.2% in 2012. We can see that the vaccination rate fluctuates between years, likely due to public awareness and concern about risks arising from more virulent strains in specific years. As flu vaccination rates vary, health care policies to promote flu vaccination among Canadians would appear to be a good idea. Research on the determinants of an individual receiving flu vaccination is important because of this.

The individual determinants of influenza vaccination have been analyzed by previous studies to explain the slow growth of take-up rates (e.g., Mullahy 1999, Lebrun 2012). Identifying which factors could influence the propensity to get a flu shot positively or negatively is essential for the design of influenza vaccination programs (Schmitz and Wubker, 2011). Better designs for influenza vaccination programs could lead to a higher take-up rate among the target population since they will help increase people's awareness of the importance of getting the vaccine.

This paper aims to provide empirical evidence about the individual determinants that

[1] See Quebec Portal (2011), New Brunswick Office of the Chief Medical Officer of Health (2013), Government of Newfoundland and Labrador Department of Health and Community Services (2012), Immunize BC (2012).

influence Canadians' propensities to obtain a flu shot. I use the latest 2012 data set of the Canadian Community Health Survey (CCHS). To explore the determinants further and more specifically, I divide the sample into three subgroups by age: young (from 18 to 34 years), middle aged (from 35 to 64 years) and seniors (65 years and over). The impact of factors on the likelihood of individuals in each age group getting a flu shot are compared and discussed.

The principal contribution of this paper is the use of the most up-to-date data, as the virulence of a particular season's influenza virus changes from year to year as does the likelihood of vaccination. Therefore, it is important to use the most recent survey data to get the most up-to-date results.

The plan of the rest of the paper is as follows. Section 2 presents a review of the existing literature that studies the factors influencing influenza vaccination take-up rates. Section 3 describes the data set, the dependent variable and the independent variables. Section 4 gives a brief description of the econometric model. Section 5 discusses estimation results and findings. Section 6 summarizes the principal findings and discusses the limitations of the paper.

1. Literature Review

There are many existing studies of influenza vaccination rates. In this literature review I focus on empirical studies of the determinants of influenza vaccination rates. Each section reviews studies for a particular geographic area, in particular, the United States, Europe and the Middle East, and Canada.

2.1 American Studies

Mullahy (1999) discusses two main economic determinants which could influence Americans' propensity to take up influenza vaccinations. According to Mullahy, these two factors are the individual's employment situation (labour supply) and "the extent to which individuals' perceived risks of infection may affect their propensities to be immunized" (Mullahy 1999, 10). Using US micro data from the Health Promotion and Disease Prevention (HPDP) supplement to the 1991 National Health Interview Survey (NHIS), he estimates an OLS regression with independent variables related to the labour market (e.g., work hours, monthly earnings), risk factors (e.g., at least one adult in the household works in a health care occupation, age, etc.) and other demographic variables (e.g., gender, race, etc.). Since some of the observed covariates in his model may be correlated with the error term, he also implements two instrumental variable strategies, one of which consists of using the state-level unemployment rate as a baseline instrument, and another which involves using family size and marital status as instruments. Mullahy finds that one's employment situation strongly affects one's willingness to obtain a flu shot, and that the healthier an individual considers himself to be, the lower his propensity to take up a flu shot.

In addition to the factors Mullahy includes in his model, some more abstract factors, such as one's social network, can affect flu shot take-up as well. Rao, Möbius and Rosenblat (2007) include this interesting factor with the help of media records. Their results suggest that young people tend to make choices regarding influenza vaccination take-up based on their peers' decisions. In other words, the decisions of friends and peers play a role in affecting an individual's propensity to obtain preventive care. According to the paper, Rao, Möbius and

Rosenblat use three different sources of data: social network information data which was collected at the website facebook.com, “House Experiment” data which describes the self-perceived health and attitude towards influenza and flu shots of random undergraduate students at Harvard University, and “a record of the students’ vaccination histories.” After estimating a series of probit and OLS models, the authors conclude that social networks do raise the impact of flu shot promotion. An individual’s flu shot take-up decision will be influenced in a positive way by whether his or her peers obtain influenza vaccinations, which means that students tend to get flu shots as well if their peers get them.

Instead of studying individuals’ propensities to get flu shots, Özaltın, Prokopyev, Schaefer and Roberts (2011) research policy aspects of flu shot design, such as the timing of its manufacturing. Because the type of influenza virus changes all the time, it is important to design new influenza vaccines. They build a multistage stochastic mixed-integer model and use 2008-2009 US seasonal flu data to calibrate the model. Finally they come to the conclusion that the principal issues in flu shot design are the composition of the influenza vaccine and the timing of its manufacturing, given that influenza happens seasonally most of the time and the effect of flu shots can last for one season or more than one season.

In contrast, Yoo and Frick (2005) discuss flu shot timing. Dividing their sample into different subpopulation groups, they examine the factors that affect the timing of people’s decisions to get flu shots, either early or late. Yoo and Frick pose three hypotheses about why some people choose to get an influenza vaccination early, while others get the vaccination late: a) some individuals are waiting to go to a clinic later to get other health care; b) people may change their mind due to updated information; c) some people decide to get a flu shot but can’t make it because of random reasons. To test these three hypotheses, they build a single equation probit model and two sequential response models (a bivariate probit model and a trivariate probit model). Yoo and Frick focus on a different aspect of flu shot take-up and shed light on future studies of flu shot take-up. They find that different perceived risks, chronic condition levels and costs of getting a flu shot influence individuals’ decisions about when to get a flu shot.

2.2 European and Middle Eastern Studies

Maurer (2009) quantifies the extent to which supply and demand factors affect the decision to take up flu shots. He builds a semi-parametric double index binary choice model, focusing on data from Germany. To support his theoretical model, Maurer also examines some common individual micro-determinants, such as age, education level and self-perceived health, which could cause an impact on both the supply side and the demand side of flu shot take-up. Also, he mentions that the reason for the inefficiency of influenza vaccination take-up programs could be asymmetric information. Some patients have inaccurate perceptions about their health care needs. In conclusion, Maurer suggests that to increase flu shot take-up rates, governments can work on the determinants of the supply of and the demand for influenza vaccinations. Physician agency, physician quality, patients’ education and health behaviors are key determinants that governments need to pay more attention to.

In a subsequent study, Schmitz and Wubker (2011) carry out a restricted investigation which only examines the flu shot take-up of elderly Europeans, since older people are more vulnerable to influenza and it can result in more serious complications for them. In their paper, Schmitz and Wubker analyze why there exists a gap between actual flu shot take-up rates and the European recommendation for flu shot take-up rates. Here education and awareness of health care may play an essential role. Secondly, and most important, they explore the crucial micro-determinants that have an influence on elderly Europeans' flu shot take-up rates. One of the micro-determinants they include is physician quality. Following Maurer (2009), Schmitz and Wubker construct more accurate physician quality scores, which are less influenced by health status. After specifying an econometric model containing crucial determinants (e.g., age, physician quality index, chronic conditions, etc.) and carrying out OLS estimation, as well as estimating a probit model, they conclude that age, health status, lifestyle, employment status, and family structure have the biggest impact on flu shot take-up rates for elderly Europeans. Age, health status (worse self-assessed health), family structure (having a partner), lifestyle (engaging in healthy behaviour) and employment status (working full time) have a positive impact on vaccination rates.

Shahrabani and Benzion (2006) conduct research into the socioeconomic factors that affect people's decisions to get flu shots in Israel, since Israel has a lower flu shot take up rate than other countries. They estimate a probit regression model to test the importance of the factors. The results show that being a post-1990 immigrant from the former Soviet Union, living in a densely populated house, being unmarried and smoking will reduce the probability of getting a flu shot for people in Israel.

Most recently, Carman and Mosca (2014) investigate the effectiveness of the Netherlands' expansion in coverage of flu shots in 2008. Before 2008, the flu shot program only covered elderly people aged 65 and older. After 2008, the flu shot program covered people aged 60 and older. In order to test whether the expansion of flu shot coverage was beneficial, Carman and Mosca estimate a probit regression model (with both a difference-in-differences model and a difference-in-difference-in-differences model). Also, they discuss the determinants that could influence people's decisions to take up flu shots. In analyzing their econometric results, they find that whether the individual had obtained a flu shot in the previous year is a key element that influences flu shot take-up after 2008. The barrier to vaccination take-up is the insufficiency of useful information and education, which corresponds to Maurer's (2009) conclusion.

2.3 Canadian Studies

Ward (2014) explores the external effects, benefits and overall influences of the influenza vaccination program in Ontario, in particular the Ontario Universal Influenza Immunization (UIIC) program which was introduced in 2000. She puts the primary emphasis on the Ontario flu shot program. Her efforts fill a gap in that there are not many articles discussing the external effects of flu shots. Ward concludes that the higher are flu shot take-up rates for young people, the more external effects will be generated for elderly people. Also, the local immunization rate has an impact on the benefits gained from the influenza vaccination program.

Kwong et al. (2006) examine the relationship between the introduction of the Ontario UIIC program and the change in influenza vaccination rates. Using data from the 1996/97 National Population Health Survey and the 2000/01 and 2003 Canadian Community Health Survey, they carry out multiple logit regressions and Z tests for different age groups and for

Ontario and other provinces. The results indicate that the UIIC program does help raise the influenza vaccination rate in Ontario. In addition, the vaccination rates for people younger than 65, the better educated, and those with a higher income level increase the most. However, the vaccination rates for younger people are still below the target rate. Thus more improvement is needed, especially regarding younger people.

Polisena et al. (2012) carry out a study of the effect of the UIIC program as well. They compare the influenza immunization rate in Ontario with the rate in other provinces. To carry out the comparison, they conduct logistic regression analyses to obtain the odds ratios between province of residence and influenza immunization rates in 2007/2008 of Canadians, before and after adjustment for covariates. The results indicate that Ontario has a relatively higher influenza immunization rate than the other provinces. Also, other factors are included to study the influenza immunization rates, such as chronic disease status, age, gender, income, education, smoking status, whether the individual has a regular medical doctor and self-perceived health. Chronic disease status, age and having a regular medical doctor increase the flu shot take-up rates.

Andrew et al. (2004) explore the influenza vaccination rates of elderly Canadians (aged 65 and over) and factors that influence their vaccination rates, by conducting a multivariate analysis. They first collect data from the Canadian Study of Health and Aging (CSHA) and also carry out a self-administered risk factor questionnaire. Then Chi-squared tests, a one-way ANOVA and a multivariate analysis are carried out. Their estimation results suggest that being married, education level, smoking, alcohol use, self-rated health, regular exercise and urban living are important individual determinants of getting flu shots.

In a broader study, Lebrun (2012) explores the determinants of immigrants' access to health care in both Canada and the United States. Lebrun pays particular attention to years since immigration and proficiency in official languages. She uses cross-section data from 2007 to 2008. Logistic models of health care use that include length of stay and language proficiency as explanatory variables are estimated and odds ratios are calculated. The dependent variables include whether the individual had visited a dentist, or an eye doctor, whether the individuals had received a flu shot in the past year and whether the individual had had a Pap test. Lebrun comes to the conclusion that Canada provides better health care access for immigrants than the United States does. Furthermore, immigrants who have a longer period of residence in the their new country and who are more proficient at official languages have higher rates of getting access to health care or health care use. In particular, being single, black and having limited official languages proficiency are associated with lower odds of getting a flu shot. Her results suggest that governments need to implement more effective health care policies regarding immigrants.

Zhdanava (2013) examines the determinants of seasonal flu vaccination between 2000 and 2011 by estimating linear probability models, using data from the CCHS that cover 2000, 2003, 2005, 2007, 2008, 2009, 2010 and 2011. She finds that age, chronic conditions, new flu virus and provincial vaccination policies are highly correlated with influenza vaccination rates in Canada.

In addition to the research of scholars, the government of Canada has also studied the influenza vaccination take-up rate. Since 2001, the Public Health Agency of Canada has carried out the Adult National Immunization Coverage (aNIC) survey routinely and calculated the vaccine take-up rate. The 2012 survey is the most recent one. PHAC (2014a) uses data from the surveys to study immunization coverage. Frequency distributions and cross-tabulations are presented for each variable. In the report logit regression models are estimated to test the importance of various predictors. According to the results, getting a vaccination recommendation from health professionals can increase influenza vaccination rates, but immunization coverage is still below national goals. Thus, more resources in the form of education and health care workers should be devoted to influenza vaccination programs.

2.4 Summary

As this literature review demonstrates, there have been quite a few studies of influenza vaccinations. What interests me the most are the micro-determinants of the flu shot take-up rate. Most of the studies use probit or logit models to test the importance of individual determinants, which inspires me to estimate a logit model as well. The existing literature also gives me some insight into what variables to include. Besides socio-demographic factors (e.g., age, gender, family structure, education level, income level, etc.) and chronic conditions, I also choose smoking, drinking, having a regular doctor, province of residence, etc. These variables have appeared in previous studies as well.

3. Data

For the purposes of this paper, I use public use data from the 2012 annual component of the Canadian Community Health Survey (CCHS), which is the most recent and up-to-date health data set available. The CCHS is an annual survey which began in 2000 that gathers health related population-level information (Health Canada 2014).

The CCHS contains many variables related to the factors that affect Canadians' decisions to get a flu shot. For my analysis, I selected the variable "had flu shot – last time" as the basis of the dependent variable, and gender, marital status, at least one child younger than 12 in household, self-perceived health, have a regular doctor, smoking, drinking, has asthma, has arthritis, has COPD (chronic obstructive pulmonary disease), has diabetes, has heart disease, has cancer, has stroke, has obesity, province of residence, employment status, length since immigration to Canada, highest level of education and income level as the explanatory variables.[2]

The full sample consists 61,707 observations. The data set I use for my analysis contains 39,646 observations. 16,955 observations were lost due to missing data, etc. 5,106 observations are lost because I exclude data for individuals aged under 18. I exclude these individuals because individuals younger than 18 years are not considered adults. As a result, their parents likely make the decision to get a flu shot for them. Thus whether they get flu shots or not will not contribute to the empirical analysis. The sample is divided into three age groups: young (aged from 18 to 34), middle-aged (aged from 35 to 64) and seniors (aged over 65). Table 2 presents the definitions of the variables.

3.1 Dependent Variable

As mentioned above, I chose "had flu shots – last time" as the basis of the dependent

[2] A complete list of all the CCHS variables used can be found in appendix table A1.

variable. Since the main purpose of this paper is to examine the micro-determinants that influence an individual's propensity to get a flu shots in Canada, the dependent variable should indicate whether the individual received an influenza vaccination or not. Furthermore, flu shots are not effective forever; usually a flu shot will last for one year after it is injected (CDCP 2014). It is recommended that individuals get flu shots annually. I use the variable "had flu shots – last time" instead of "Ever had a flu shot", due to the fact that a vaccination will lose its effectiveness after one year. An individual cannot be immune forever after they get a flu shot.

Using the variable "had flu shots – last time," I generate a binary dummy variable as the dependent variable. Respondents in the original survey indicated how long it had been since their last flu shot: "< 1 year," "1 to <2 years," "2 years or more," "not applicable," "don't know," "refusal" and "not stated." Since flu shots are most effective for one year, this new dummy variable is set equal to 1 (the individual received a flu shot) when the response is "< 1 year." The new dummy variable equals 0 (the individual did not get a flu shot) when the response is "1 to <2 years" or "2 years or more." The remaining responses are "not applicable," "don't know," "refusal" and "not stated." They are treated as missing values.

Table 3 presents summary statistics for the dependent variable for three age groups and the full sample. It is obvious that the flu shot take-up rate of seniors is the highest among these three subgroups, at approximately 65 percent. Young people have the lowest rate at 16.7 percent, while the rate for the middle-aged group is approximately 30 percent. These differences can be explained by the fact that young people are generally in good health and thus not worried about getting flu shots. On the other hand, elderly people tend to be less healthy and face the highest risk of getting the flu. Flu may also lead to serious complications for elderly people.

The middle-aged group has the largest number of observations, which implies that people aged from 35 to 64 were the dominant group in Canadian society in 2012.

3.2 Independent Variables

According to Mullahy (1999), an individual's decision to get a flu shot is an example of the demand for preventive care under uncertainty. The individual doesn't know whether he or she will get flu. Therefore the individual makes his decision by maximizing his expected utility, subject to the budget constraint. One's health utility depends on one's background health, for example, the risk of getting flu. The risk factors may include age, chronic conditions, self-perceived health status, etc. The cost of getting a flu shot depends on a) provincial flu shot policies, since some provinces provide free flu shots and some don't ; b) employment status, since visiting a doctor could involve a time cost of getting a flu shot; and c) wage rate. Also, an individual makes his decision based on some socio-demographic factors, such as gender, marital status, family structure, education level, time since immigration to Canada, etc. In addition, the probability of vaccination can also be influenced by one's attitude towards health. I chose the independent variables based on this framework.

Age is one of the risk factors. Usually elderly people (aged over 65) face the highest risk of flu complications. Dummy variables are generated for each age group. If an individual is aged from 18 to 34, the variable *youth* equals 1. If an individual is aged from 35 to 64, the variable *middleage* equals 1. The variable *senior* equals 1 if the individual is aged over 65.

Instead of using age as an explanatory variable, I estimate separate models for the different age groups.

Another important risk factor is whether or not the individual has a chronic condition. The Ontario government notes on its website that people who have a chronic condition face a higher risk of complications from the flu. Once they get influenza, the problems that result may even cause their death. The Ontario government strongly recommends that one should get a flu shot

> [i]f you have one of the following chronic conditions, as you are more at risk of developing complications from the seasonal flu:
>
> - heart disease
> - kidney disease
> - asthma and chronic lung disease
> - liver disease
> - diabetes
> - serious obesity
> - diseases or treatments that affect the immune systems such as cancer, HIV/AIDS, organ transplants
> - blood disorders
> - neurological disorders
> - medical conditions where people have difficulty swallowing or are at risk of choking
> - children’s and adolescents' medical conditions treated for long periods with acetylsalicylic acid (Aspirin®).
>
> (OMHLTC 2013)

Unfortunately the CCHS does not include information about all of these conditions (e.g., kidney disease, liver disease and HIV/AIDS), but information on quite a few of them is available. Following the method used in Schmitz and Wubker (2011), I create individual dummy variable indicators for as many chronic conditions as possible. Each dummy variable is set equal to 1 if the individual has the chronic condition, and 0 otherwise. The chronic conditions included in the model are asthma, arthritis, COPD (Chronic Obstructive

Pulmonary Disease),[3] diabetes, heart disease, cancer, stroke and obesity.

Self-perceived health is also a risk factor. The hypothesis is that worse self-perceived health will increase the probability of getting flu shots, since worse health status may increase the chance of being infected. I use the self-perceived health variable in the CCHS. The respondents categorize their health as "excellent," "very good," "good," "fair" or "poor." Since Schmitz and Wubker (2011) use only one variable for the variable self-accessed health and the definition of that variable is "Excellent = 1 to poor = 5", and their models work well, in my model I also use the original variable for self-perceived health as well, renaming it *selfhealth*.[4]

Whether there is a fee influences the cost of getting a flu shot. As discussed in the introduction, in Canada different provinces have implemented different policies with respect to the coverage of flu shots in their provincial health care systems. Quebec, New Brunswick, Newfoundland and Labrador and British Columbia provide free flu shots only for high-risk groups. The rest of the provinces provide free flu shots to all their residents. To explore whether the provincial effect is important in the flu shots take-up model, a geographic dummy variable is created for each province or territory to indicate the location of current residence. Each provincial dummy variable equals 1 if the individual lives in that province or territory. In the CCHS data set, 10 provinces are identified, while the three northern territories are grouped together. Ontario is considered to be the benchmark.

Employment status influences both the money cost and the time cost of vaccination. According to the argument of Schmitz and Wubker (2011), employment status could

[3] COPD is a form of lung disease.
[4] I also test whether the restrictions implied by the use of this categorical variable are correct.

influence the propensity to obtain an influenza vaccination in two opposite ways. In the first case, once employed individuals get influenza, they cannot go to work because of their influenza infection and may fall behind in their work schedule or lose some salary. To reduce the risk of this happening, employed individuals tend to get flu shots. In the second case, employed individuals place a higher value on their time, and thus a vaccination is more costly. They may not want to spend the time or money to get a flu shot. To study the impact of employment status, I include a variable that indicates whether or not individuals are employed, using a variable in the CCHS that classifies individuals as “employee”, “self-employed” or “not applicable”. Apparently “not applicable” refers to all non-working individuals. In my model, “employee” and “self-employed” are grouped together as employed individuals. A dummy variable *employment* is generated that is equal to 1 if the individual is employed. If the person is unemployed, *employment* equals 0.

Income level may also have a potential impact on the decision to get a vaccination. The higher the income an individual or household has, the better able they are to finance the cost of a vaccination. I choose the total household income per year as the income variable since people consider a household as a social unit. The income level data in the CCHS data set is categorized into 5 levels: “None or <$20,000,” “$20,000-$39,999,” “$40,000-$59,999,” “$60,000-$79,999,” “$80,000 or more”. A dummy variable is created for each category, such that it equals 1 if the respondent’s income falls in that category.

Beyond the risk factors and variables that have an impact on the cost, some socio-demographic factors may have an impact on the probability of getting a flu shot. One of the socio-demographic factors is gender. The hypothesis is that women are more risk averse than men (Maurer 2009). They may be more willing to stay healthy and get vaccinated due to their family responsibilities. The dummy variable *male* is set to 1 when the individual is a man and the dummy variable *female* equals 1 if the individual is a woman.

According to previous studies, household structure also tends to have an important influence on the propensity to get a flu shot. Relevant aspects of household structure include marital status and having children younger than 12 years. If a person is partnered, the opportunity to be infected with influenza is higher than for single people because partnered people have lots of connections with their partners in their daily life. Thus they will be infected too once their partners get the flu, while single people should be less worried about this. Married and common low individuals are both counted as partnered. The rest are counted as un-partnered. A dummy variable is generated, such that it equals 1 when the individual is partnered, and 0 otherwise.

Influenza is a contagious disease. Children, especially children aged under 12 years, randomly bring disease viruses home from outside. Children go to school and have contacts with either their peers or teachers every day. This increases the chance of getting an influenza infection from other people. Thus parents who have younger children at home usually face a higher risk of getting influenza than people without kids. So having young children may affect the willingness to get flu shots positively. The dummy variable *kids* is set equal to 1 when the individual has at least one child less than 12 years old in the family.

Time since immigration is another potential socio-demographic characteristic. People born in Canada are likely to have better knowledge of the Canadian health care system than immigrants; immigrants who have just landed in Canada may not have much knowledge of how the Canadian health care system works or what the health care system can provide. As a result, the propensity of immigrants to obtain flu shots may be lower than that of Canadian-born people. However, there is also another possibility: immigrants may regard the fact that Canada has a long and cold winter as an inducement to obtain a flu shot. To test for an immigrant effect, two dummy variables are included. The variable *morethanten* is set equal to 1 if the individual has been in Canada for more than ten years since immigration, and equals 0 if the time since immigration is shorter than ten years or the individual is not an immigrant (i.e., born in Canada). The variable *nineyear* is set equal to 1 if the time since immigration is nine years or less, and equals 0 if the immigrant has been in Canada longer or if the individual is not an immigrant.

Education level, another socio-demographic characteristic, may influence an individual’s information set and thus influence the demand for flu shots (Maurer 2008). With the education gained from school, people have the opportunity to acquire important information about the influenza virus. For example, the knowledge usually is taught in biology class and depends on their educational attainment. Education level may cause differences in access to the health care literature. Appropriate education helps people understand why it is important to get a vaccination and what can prevent flu shots. According to Maurer (2008), better educated individuals tend to be more willing to get flu shots. Thus the hypothesis is that the higher the level of education people achieve, the higher chance they will get an influenza vaccination.

I use the highest level of education as a measurement of education. In the CCHS, the highest level of education of the household is classified as “< than secondary,” “secondary grad,” “post-sec grad” or “other post-sec.” I group “post-sec grad” and “other post-sec” together and call “*atleastpostsec,*” because “post-sec grad” and “other post-sec” indicate people who have attended a post-secondary program. Dummy variables are created for each educational category. I call the category “< than secondary” *elementary,* and the category “secondary grad” *secondary. Atleastpostsec* is used as benchmark. The variable *elementary* equals 1 if the person’s highest level of education is less than secondary school. The other two dummy variables are defined in a similar fashion.

The recent literature suggests that having a regular doctor has an important impact on the flu shot take-up rate. Polisena et al. (2012) claim that having a regular doctor influences people’s willingness to get flu shots positively. To test the impact of having a regular doctor, the dummy variable *doctor* is included, such that it equals 1 if the individual has a regular medical doctor.

Some variables may play two roles in influencing individuals’ decisions to get a flu shot. For example, smoking and drinking can be risk factors or indicators of the individual’s attitude towards his or her health (Shahrabani and Benzion, 2006). On the one hand, smoking and drinking have negative side effects on health, especially smoking. For example, smoking too much can cause lung disease. Similarly, bad drinking habits harm organs, such as the heart, liver and kidneys. All these diseases result in individuals facing a higher risk of getting influenza. Thus people with smoking or drinking habits may be more likely to get flu shots. On the other hand, people who smoke or drink a lot can also be considered to be people who don’t care about their health that much. An individual who doesn’t care about his health may be less willing to get a flu shot. To study the impact of smoking and drinking, dummy variables are included for both. The dummy variable *smoke* identifies daily smokers, while the dummy variable *drink* identifies those who drink almost every day. *Smoke* equals 1 when the person is a daily smoker. *Drink* equals 1 when the person drinks every day or 4-6 times per week.

Table 4 presents some summary statistics for the independent variables. The statistics are calculated for the three age groups: young (aged from 18 to 34), middle-aged (aged from 35 to 64) and seniors (aged 65 and over). The table provides the means of each variable, with the standard deviations in parentheses below each mean.

There are no individuals with COPD in the young subsample, so in estimation, I will exclude the variable COPD from the model for the young age group.

For the variables *male. female*, *selfhealth* and *doctor* and the provincial dummies, the three age groups have relatively similar means. The percentage having at least one child under 12 years is only 0.49% for seniors, which is the lowest. The percentage having asthma is the highest for young people. For *arthritis, copd, diabetes, heartdisease, cancer*, *stroke*,and *smoke*, the means for younger age groups are the smallest. For *obese*, the middle-aged group has the largest mean while the young and seniors age groups have similar means. This implies that chronic conditions are more common among middle-aged people and seniors. For *smoke*, seniors have the lowest mean, which is almost one-tenth of the mean for the young age group, and seniors have the largest mean for *drink*. Younger adults tend to have higher income levels, since their mean for income level “$80,000 and more” is 0.45 and is the largest. Seniors have the lowest average for *employment* since more elderly people are retired. More seniors than other age groups have been landed in Canada for more than ten years, while more young adults have been in Canada for less than 10 years.

4. Model

In my model, the dependent variable is a binary choice variable indicating whether an individual received a flu shot or not. To study the individual determinants that influence an individual's propensity to get the flu shot I use a logit regression model. The logit regression model is widely used in the literature focused on flu shot timing and the incidence of flu shot take-up.

I choose a logit model rather than a linear regression model for two reasons. First, the dependent variable is a binary choice variable. If one uses a linear regression model, the error term will not be normally distributed and will be heteroskedastic. Second, in a logit model the predicted value of the dependent variable always lie between 0 and 1, while in a linear regression model it may not. The basic model can be described as follows:

$$P(y_i = 1) = F(x_i' \beta), \tag{1}$$

where y_i is a dummy variable indicating whether an individual has received a flu shot in the last 12 months, x_i is a vector that includes all the explanatory variables discussed in section 3, β is a vector of coefficients to be estimated and *i* indexes individuals. The function $F(\cdot)$ in equation (1) is given by

$$F(x_i' \beta) = \frac{e^{x_i' \beta}}{1 + e^{x_i' \beta}} \tag{2}$$

In a logit model, the coefficient estimates alone do not measure the effects of the independent variables, since P($y_i = 1$) is a nonlinear function of the independent variable. Thus, to measure the effects of the independent variables that I include in my model, I compute their marginal effects. The marginal effect is the effect of a change in an independent variable (e.g., x_{ij}) on the expected change in the probability that the dependent variable will equal 1. For continuous variables it can be computed by taking the partial derivative of $E(y|x)$ with respect to x_{ij}; for dummy variables it is the discrete change in $\mathrm{P}(y_i = 1)$ as the independent variable changes from 0 to 1. There are three ways to evaluate the marginal effects: at sample means, for a reference individual, and by computing the average partial effect. Evaluating at sample means is problematic because the sample means of dummy explanatory variables rarely have a sensible interpretation. Thus, I choose to evaluate them at the characteristics of the reference individual, the individual for whom all included dummy variables are set to zero.

The next section will discuss the estimation results.

5. Results

I estimate logit models for each of three age groups: young (aged 18 to 34 years), middle-aged (aged 35 to 64 years), and seniors (aged 65 years and over). The estimation method is the method of maximum likelihood.[5] For the purposes of calculating the marginal effects, the reference individual is defined as an individual who is male, single, has no children younger than 12 years, has excellent self-perceived health status, has no chronic conditions, is not a daily smoker or drinker, is not employed, has attended a post-secondary program, lives in Ontario, has no regular doctor, has an annual income of at least $80,000 and was born in Canada. Table 5 reports the marginal effects for each group.

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[5] All estimation was carried out using version 10 of Stata.

The pseudo R-squared values for the young, middle-aged and seniors are 0.0442, 0.0581 and 0.0602 respectively. Since the bigger the R-squared value is the better the goodness of fit of the model will be, this logit model fits the seniors group better than the other groups. But these three values are not close to 1, so it doesn't fit the sample perfectly. However, LR tests that the slope coefficients are jointly zero show that the model still has explanatory power. The LR chi-squared values are 364.12, 1449.14 and 773.65, while the p-values are all 0.000 for the three sub groups. Thus the null hypothesis that the model doesn't have explanatory power can be rejected. This means that this model does have explanatory power for the sample. Therefore, although this logit model doesn't fit the sample that well, it is still significant for all three groups,

In addition, I carried out a joint hypothesis test related to the treatment of self-perceived health in the model. In the new logit model, four dummy variables representing categories of self-perceived health – excellent, good, fair, and poor – are included, and *selfhealth* is excluded. Then a Wald test of the null hypothesis that the restrictions implied by including self-perceived health rather than the four dummy variables was carried out.[6] The results show that for the young and middle-aged groups, the null hypothesis cannot be rejected at the 5% significance level, which means that including *selfhealth* is appropriate, while for the seniors group, the null hypothesis is rejected.[7] However, the marginal effects of the independent variables do not change much for seniors. Thus table 5 reports the marginal effects of the restricted model for seniors as well as for the young and the middle-aged.

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[6] The exact null hypothesis tested was that the sum of the coefficients of *excellent* and *good* equals 0, the coefficient of *fair* equals twice the coefficient of *good*, and the coefficient of *poor* equals seven times the coefficient of *good*.

[7] The test statistic values for the young group, middle-aged group and seniors group are 4.57, 1.90 and 32.03. The p values are 0.2061, 0.5944 and 0.0000.

5.1 Results for the young

The young sample has 9,114 observations and consists of individuals aged from 18 to 34. Overall, a number of marginal effects are significant at at least the 10% level of significance for this group. The predicted probability of getting a flu shot for the reference individual is 11.5%.

To start with, the impact of risk factors is discussed. For young people, chronic conditions do not play an important role as compared to the other two age groups. This finding could be explained by people's different attitudes towards evaluating their risks. Younger people may be less risk averse and less concerned about risk than older people. They might not be worried about flu complications. However, asthma, diabetes and obesity do affect young people's behavior in a positive way. Among these conditions, diabetes has the largest marginal effect. Asthma, diabetes and obesity are relatively common diseases among young people.

Another risk factor is self-perceived health. The marginal effect of self-perceived health is significant at the 5% significant level. Since excellent = 1 and poor = 5, self-perceived health status worsens as the value of *selfhealth* increases. Therefore, the results imply that worse self-perceived health has a negative effect on the likelihood of younger adults getting flu shots. This may be because younger adults who have better self-perceived health tend to be more willing to get vaccinations to stay healthy.

As for the factors that influence the cost of getting a flu shot, provincial factors have an impact on the propensity for the young group to get a flu shot. According to the estimation results, residents of Newfoundland and Labrador, Quebec and Manitoba are less likely to get flu shots than those in Ontario. The propensity to get flu shots is lower for people living in Newfoundland and Labrador, Quebec and Manitoba by 3.55 percentage points, 4.81 percentage points and 2.81 percentage points respectively. Andrew et al. (2004) also find that residents in Quebec are less likely to get flu shots. The governments of Quebec and Newfoundland and Labrador provide free flu shots to high risk groups, but not to everyone.[8] The cost of getting a flu shot will be higher for those living in these two provinces compared to Ontario, since Ontario provides free flu shots to everyone. This higher cost may deter people from getting vaccinated. On the other hand, the government of Manitoba provides free flu shots, so the lower rate in Manitoba can not be explained by different policies with respect to flu shot coverage. Unfortunately my data set doesn't provide more information regarding its reason.

Income level also influences the willingness to get flu shots. Interestingly, the marginal effect of *income3* is -0.0164. If a young person has total income in the range of $40,000 to $ 59,999 per year, the probability of him getting a flu shot decreases by 1.64 percentage points. This result implies that younger adults with income in the range of $40,000 to $ 59,999 are less likely to get flu shots than those with higher income in the range of over $80,000.

Next the impact of socio-demographic factors is discussed. The marginal effect of *female* is significant at the 1% significant level for young adults, which means that the probability of getting a flu shot will increase by 5.34 percentage points if the individual is female, holding all else constant. A possible explanation is that women seem to care more about their health,

[8] See Quebec Portal (2011), Government of Newfoundland and Labrador Department of Health and Community Services (2012).

especially young women, due to family responsibilities, such as taking care of the family and children. Besides, this result may also be related to the fact that the majority of teachers and nurses are women; teachers and nurses are both more likely to be exposed to flu than those in most other occupations. This is consistent with Maurer (2009) who also finds that females are more likely to get an influenza vaccination.

In addition, having at least one child younger than 12 years influences the probability of getting a flu shot. The probability will rise by 5.39 percentage points if there is at least one child younger than 12 years in a household. This result is consistent with the hypothesis that younger children tend to bring the flu virus from outside, either from school or from their peers.

Another socio-demographic factor that could influence influenza vaccination rates of younger adults is education level. According to table 5, interestingly, the marginal effect of *elementary* is not significant. But the marginal effect of *secondary* is significant at the 10% level. If one's highest education level is secondary school, one's propensity to get the vaccination will decline by 2.97 percentage points. In other words, people who have attended a post-secondary program are more likely to get flu shots than secondary grads. Better educated people have greater demands for influenza vaccination or preventive health care (Mullahy 1999).

For the factors which may play two roles, smoking and drinking are significantly negatively associated with the probability of getting an influenza vaccination. This is consistent with my hypothesis that smoking and drinking reflect attitudes towards health care. As is well known, smoking and drinking frequently harm one's health directly. Apparently, heavy smokers or drinkers may not be bothered about keeping healthy or getting vaccinations.

Whether or not the individual has a regular medical doctor is also a significant factor. The probability of getting the influenza vaccination is 3.58 percentage points higher for young individuals with a regular doctor, holding all else constant. This is consistent with the results of previous studies such as Polisena et al. (2012). Individuals who have a regular doctor are more likely to get a flu shot, perhaps because their doctor advises them to do so. Another reason could be that people with a regular doctor care more about their health, and thus are more willing to get a vaccination to stay healthy.

5.2 Results for the middle-aged

The second column of Table 5 presents the marginal effects of the logit model for the middle-aged group (people aged from 35 to 64). This subsample is the largest with 20,552 observations. Note that for this sub sample, the variable *copd* is included. The predicted probability that a middle-aged reference individual will get a flu shot is 15.33%. It is clear that many of the marginal effects are highly significant, especially compared to the young group, which suggests that the model fits this group better than the young group.

First of all, the risk factor chronic condition is discussed. Unlike the younger adults, for the middle-aged group all the chronic conditions are important micro-determinants of the propensity to get an influenza vaccination. Compared to the young subsample, chronic conditions generally have bigger marginal effects for this age group. The marginal effects of *asthma, arthritis, diabetes, heart disease, cancer, stroke, copd* and *obesity* are significant at the 1% level, while the marginal effect of *stroke* is significant at the 10% level. All these chronic conditions increase the flu shot take-up rate; among them, *diabetes* has the largest marginal affect. The flu shot take-up rate rises by 11.5 percentage points if a person has diabetes. Still, individuals with chronic conditions face a higher risk of being infected by influenza, and should they get it, flu will harm their health in return. In addition, middle-aged people are more risk averse than younger adults. This could explain why chronic conditions have a stronger impact for middle-aged people than for younger adults.

Worse self-perceived health has a positive impact on middle-aged people's willingness to get flu shots, which differs from the result for young adults. This finding is compatible with the results in Mullahy (1999) and Schmitz and Wubker (2011). Mullahy (1999) explains that flu complications are more serious for unhealthy individuals than for healthy individuals. He also notes that individuals who consider themselves to be in poor health contact health care workers more often and thus have more chances to obtain vaccinations.

The provincial effects for the middle-aged group are similar to those for the young group. Newfoundland and Labrador, Nova Scotia, Quebec and *YT* have the same impact on the decisions of the middle-aged group as on the young group. Among them, Nova Scotia has the largest positive marginal effect, which could increase the probability of getting a flu shot by 7.6 percentage points.

Employment status is negatively associated with the probability of getting a flu shot for the middle-aged group, which differs from the result for the young group. If the person has a job, the probability of getting a vaccination declines by 2.72 percentage points. My result corresponds with the hypothesis that working individuals already have high opportunity costs and they don't want to incur more costs by getting a flu shot, since getting a flu shot will cost them time and money.

Income level has an impact on middle-aged people's flu shot take-up rate as well. If a middle-aged person has an annual household income in the range of less than $20,000 , the rate of getting flu shot is 2.77 percentage points lower. An annual income of less than $20,000 is considered to be low income, according to Lebrun (2012). People with low income may not want to spend money on preventative health care; in other words, they are less willing to get flu shots than people with higher incomes. Shahrabani and Benzion (2006) conclude that the higher an individual's income, the more likely it is that he will get a flu shot.

As one of the socio-demographic factors, the variable *female* is correlated with the flu shot take-up rate significantly and positively. If the individual is female, the probability of getting a flu shot will rise by 6 percentage points. The magnitude of the marginal effect is almost the same as that for the young group. The explanation is the same as for the young group.

In contrast to the results for younger adults, the *partnered* variable is significantly correlated with the likelihood of getting a flu shot. The flu shot take-up rate will increase by 1.47 percentage points if the person is either married or in a common-law relationship. This finding is consistent with the argument of Andrew et al. (2004) that married individuals are more likely to get an influenza vaccination. This may be because partnered people have a higher risk of getting an influenza infection from their partners. According to the guidelines regarding who should get a flu shot, family members of those with a chronic condition that puts an individual at high risk of complications from the flu should also get vaccinated (OMHLTC 2013). Although my data do not indicate whether respondents live with individuals who have such chronic conditions, single people are less likely to do so than partnered people.

In contrast to the young group, having at least one child younger than 12 years is negatively associated with the likelihood of getting a vaccination. The flu shot take-up rate will drop by 3.35 percentage points if the person has at least one child younger than 12 years in his family.

If one’s highest level of education is elementary school, one’s probability of getting a flu shot drops by 2.95 percentage points, while the probability declines by 2.01 percentage points if the highest level of education is secondary school. This implies that compared to middle-aged people who have attended a post-secondary program, people graduating from elementary school and secondary school (similar with the result for young group) are less likely to get flu shots. Mullahy (1999) states that better educated people have greater demand for preventive care, such as influenza vaccination. This result corresponds to his findings.

Unlike the result for younger adults, time since immigration has positive influence on the likelihood of getting flu shots for the middle-aged group. If a middle-aged person has been in Canada less than 10 years, the likelihood of him getting a flu shot will decrease by 4.35 percentage points. So a middle-aged newer immigrant is less likely to get a flu shot than a Canadian citizen or an immigrant who has been in Canada for more than ten years since immigration. Newer immigrants are less informed than local citizens or older immigrants so they tend not to get flu shots (Shahrabani and Benzion, 2006). Also it takes longer for new immigrants to get to know the Canadian health care system. Some people may not realize that some provincial governments provide free flu shots for people aged over 65 years. Or they don't know the risk of flu complications. Therefore, they don't have a high willingness to get flu shots.

As for the young group, smoking influences the flu shot take-up rate in a negative way. If an individual is a daily smoker, the probability of getting a flu shot will decrease by 4.69 percentage points. Daily smokers seem not to care about their health that much, otherwise they wouldn't become daily smokers. Shahrabani and Benzion (2006) claim that "heavy smokers tend not to get flu shots and it can be seen as evidence of an individual's more general attitude towards health care"(p. 633). In contrast to younger adults, middle-aged people's decisions to get a flu shot are not influenced by the drinking variable.

Not surprisingly, whether the individual has a regular doctor still influences the flu shot take-up rate positively. The rate is 11.9 percentage points higher, if the person has a regular medical doctor. This marginal effect is nearly three times the corresponding marginal effect of the young subsample and is also largest for this age group, which suggests that having a regular doctor is more important for the middle-aged group.

5.3 Results for the seniors

Elderly people (aged over 65 years) face the highest risk of flu complications and are strongly advised to get flu shots.[9] The third column in Table 5 demonstrates the marginal effects for seniors. The number of observation is 9,910. The variable *copd* is included as it is

[9] See Ontario Ministry of Health and Long-Term Care (2013).

relevant for this age group. The predicted probability of getting a flu shot for seniors is 47.92%, much higher than for the other two groups.

First, the risk factors are discussed. Chronic health conditions are positively significantly associated with the probability of getting a flu shot for seniors, with the exception of *stroke* and *obesity*. These results are similar to those for the middle-aged group, but slightly different from the young group. COPD has the biggest marginal effect among other chronic conditions for seniors. The rate is 11.4 percentage points higher if the senior has COPD. Elderly people with chronic conditions are strongly advised to get flu shots because influenza can cause serious health complications to them.

Self-perceived health has an inverse marginal effect in that the worse the perceived health status of an individual the greater their likelihood of getting a flu shot. Seniors have a stronger inverse relationship than the middle-aged group, while younger adults have the opposite (direct) relationship. The different impacts on different age groups may be explained by the age difference. As people age, the consequences of influenza become more severe. They may consider themselves facing higher risk when getting older. Also, seniors may be more risk averse than middle-aged and younger adults, so they are more willing to get flu shots to reduce the risk of being infected by influenza or getting influenza complications. On the other hand, in the logit model that includes dummy variables for different levels of self-perceived health, self-perceived health status has the same influence, in that worse self-perceived health increases the likelihood of getting a flu shot. However the magnitude of the marginal effect of *excellent* is slightly bigger than the restricted estimates imply. If an individual considers himself to be in excellent health, the likelihood of getting a flu shot is

6.32 percentage points lower.

The provincial factors that are associated with the likelihood of getting flu shots for seniors are slightly different from the ones for the other two age groups. Perhaps this is because people aged over 65 years are considered a high-risk group and are provided free flu shots in each province. Thus the different provincial policies regarding coverage will not influence seniors' propensities to get flu shots in the same way as the other two groups.

Employment status influences the flu shot take-up rate in a negative way. The rate is 14.4 percentage points lower if the person has a job. This marginal effect is more than four times that for the middle-aged group. Usually people aged over 65 have already retired from their jobs. If an elderly person is still working, it is either because he is in need of money or the person owns his business. Either way, the person wouldn't want to lose or spend money. Therefore, the propensity to get a flu shot is low. Income level is significantly positively associated with the probability that seniors will get flu shots. It has a stronger impact for the seniors than for young and middle-aged adults.

As for the socio-demographic factors, gender is still significant, but has the smallest marginal effect among these three age groups. The rate is 2.66 percentage points higher if the individual is female. Time since immigration is significantly positively associated with elderly people's decisions to get flu shots. The rate is 4.56 percentage points lower if an individual has been in Canada for less than 10 years since immigration. This magnitude of the marginal effect is similar to that for the middle-aged group.

As for the attitude towards health, smoking has a bigger influence on seniors than on the other two age groups. The flu shot take-up rate is 15.2 percentage points lower if a senior is a daily smoker. This marginal effect is almost three times that of the middle-aged group. Compared to seniors and the middle-aged, smoking has the smallest influence on young adults. However, in contrast to the results for young adults, drinking has no significant impact here. Thus, drinking influences younger people's propensities to get flu shots the most.

The variable indicating that the individual has a regular medical doctor has the largest marginal effect for this age group, as well as the largest among these three subgroups. If a senior has a regular doctor, their likelihood of getting a flu shot will increase by 22.2 percentage points. Doctors strongly encourage people aged over 65 years to get an influenza vaccination. This result is consistent with that of Polisena et al. (2012).

6. Conclusion

This paper analyzes the determinants of the propensities of Canadians to get a flu shot using 2012 data from the Canadian Community Health Survey. The sample is divided into three age groups: young, middle-aged and seniors. To study the factors that might influence influenza vaccination for Canadians, I estimate three logit models, one for each subsample.

To summarize, the flu shot take-up rate for seniors is the highest among the three age groups. Factors with significant marginal effects for all these three age groups are being female, having a regular doctor, certain chronic conditions and smoking. Being a resident of Newfoundland and Labrador or Quebec is negatively associated with influenza vaccination. Individuals who are female, have a regular medical doctor or have certain chronic conditions are more likely to get flu shots. The findings are consistent with previous research. For example, Polisena et al. (2012) find that having a regular doctor increases influenza vaccination rates. Maurer (2009) observes higher vaccination rates for females than for males. Andrew et al. (2004) find that vaccination rates in Quebec are the lowest among provinces.

Since residing in Newfoundland and Labrador and Quebec are negatively associated with the likelihood of getting flu shots, these two provincial governments may need to increase the promotion of influenza vaccination programs or provide more free flu shots. In addition, as men have much lower vaccination rates than women, it might be a good idea to pay more attention to preventive health care education for males.

Newer immigrants are less likely to get flu shots than either native-born Canadians or immigrants who have been landed more than 10 years for the middle-aged and seniors groups. Thus the awareness and use of current influenza vaccination services may not be sufficient for recent immigrants. More policies regarding preventive health care services for recent immigrants may need to be implemented.

One of the limitations of this paper is that the CCHS data does not provide information about whether an individual lives with someone at high health risk for influenza, or works in a setting in close contact to people who are at high risk of flu complications. In both these circumstances it is highly recommended to get a flu shot.[10] As discussed above, a middle-aged person who is partnered is more willing to get a flu shot. One of the reasons may be that partnered individuals are more likely to live with a health care worker or high risk people. Thus future research is needed to discuss the role of this factor.

Another limitation is the possible endogeneity of some of the explanatory variables. For example, the explanatory variable *doctor* may be correlated with people's aversion to risk.

[10] See Ontario Ministry of Health and Long-Term Care (2013).

Since the dependent variable might also be influenced by people's aversion to risk, it is possible that the independent variable *doctor* and the dependent variable are correlated with the same omitted factor, which might cause endogeneity. One of the possible solutions is to use instrumental variables estimation. The development of an appropriate instrumental variable strategy could be a worthy subject of future study.

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Table 1. Summary of Provincial Flu Shots Policies

Province	Universal Coverage[a]	Year Implemented[b]
Newfoundland and Labrador	No	
Prince Edward Island	Yes	2011
Nova Scotia	Yes	2010
New Brunswick	No	
Quebec	No	
Ontario	Yes	2000
Manitoba	Yes	2010
Saskatchewan	Yes	2010
Alberta	Yes	2009
British Columbia	No	
Yukon	Yes	?
Northwest Territories	Yes	?
Nunavut	Yes	?

Notes:

a. Universal coverage means that influenza vaccination is provided free of charge to all residents over 6 months of age. See PHAC (2014b).

b. See Alberta Government (2012) , New Brunswick Office of the Chief Medical Officer of Health (2013), Department of Health Government of Manitoba (2013), Saskatchewan Ministry of Health (2012), Yukon Health and Social Services (2014), Northwest Territories Health and Social Services (2014), Flighflu.ca (2012), Prince Edward Island Department of Health and Wellness (2011), Quebec Portal (2011), New Brunswick Office of the Chief Medical Officer of Health (2013), Government of Newfoundland and Labrador Department of Health and Community Services (2011/2012), and Immunize BC (2012).

Table 2. Definition of Variables

Variable	Definition
Dependent variable	
y	equals 1 if individual had his last flu shot in the last year, 0 otherwise
Independent variables	
male	equals 1 if individual is male, 0 otherwise **(reference)**
female	equals 1 if individual is female, 0 otherwise
partnered	equals 1 if individual is presently married or living common-law, 0 otherwise
kids	equals 1 if individual has at least one kid < 12 years old in family, 0 otherwise
selfhealth	self-perceived health status, values from 1 to 5
doctor	equals 1 if individual has a regular medical doctor, 0 otherwise
asthma	equals 1 if individual has asthma, 0 otherwise
arthritis	equals 1 if individual has arthritis, 0 otherwise
copd	equals 1 if individual has COPD, 0 otherwise
diabetes	equals 1 if individual has diabetes, 0 otherwise
heartdisease	equals 1 if individual has heart disease, 0 otherwise
cancer	equals 1 if individual has cancer, 0 otherwise
stroke	equals 1 if individual has stroke, 0 otherwise
obese	equals 1 if individual has obesity, 0 otherwise
smoke	equals 1 if individual is a daily smoker, 0 otherwise
drink	equals 1 if individual drinks every day or 4-6 times per week, 0 otherwise
ON	equals 1 if individual lives in ON, 0 otherwise **(reference)**
NL	equals 1 if individual lives in NL, 0 otherwise
PEI	equals 1 if individual lives in PEI, 0 otherwise
NS	equals 1 if individual lives in NS, 0 otherwise
NB	equals 1 if individual lives in NB, 0 otherwise
QC	equals 1 if individual lives in QC, 0 otherwise
MB	equals 1 if individual lives in MB, 0 otherwise
SK	equals 1 if individual lives in SK, 0 otherwise
AB	equals 1 if individual lives in AB, 0 otherwise
BC	equals 1 if individual lives in BC, 0 otherwise
YT	equals 1 if individual lives in YT, 0 otherwise
income 1	equals 1 if individual has annual income none or <$20,000 per year, 0 otherwise
income 2	equals 1 if individual has annual income $20,000-$39,999 per year, 0 otherwise
income 3	equals 1 if individual has annual income $40,000-$59,999 per year, 0 otherwise
income 4	equals 1 if individual has annual income $60,000-$79,999 per year, 0 otherwise

income 5	equals 1 if individual has annual income $80,000 or more per year, 0 otherwise **(reference)**
employment	equals 1 if individual is currently working, 0 otherwise
morethanten	equals 1 if length since immigrant is at least ten years, 0 otherwise
nineyear	equals 1 if length since immigrant is nine years or less than nine years, 0 otherwise
elementary	equals 1 if highest level of education is elementary school, 0 otherwise
secondary	equals 1 if highest level of education is secondary school, 0 otherwise
atleastpostsec	equals 1 if highest level of education is at least post-secondary school, 0 otherwise **(reference)**

Table 3. Summary Statistics of the Dependent Variable

	Count	Mean	SD
Young	9114	0.1672153	0.1392696
Middle-aged	20622	0.2931335	0.2072163
Seniors	9910	0.6492432	0.477231
Full Sample	55205	0.3697129	0.4827313

Table 4. Summary Statistics for Independent Variables

	Young	Middle-aged	Seniors
	(1)	(2)	(3)
male	0.456	0.461	0.440
	(0.498)	(0.499)	(0.496)
female	0.544	0.539	0.560
	(0.498)	(0.499)	(0.496)
partnered	0.419	0.665	0.548
	(0.493)	(0.472)	(0.498)
kids	0.337	0.195	0.00494
	(0.473)	(0.396)	(0.0701)
selfhealth	2.128	2.328	2.580
	(0.855)	(0.964)	(1.032)
doctor	0.758	0.873	0.948
	(0.429)	(0.333)	(0.223)
asthma	0.0970	0.0753	0.0718
	(0.296)	(0.264)	(0.258)
arthritis	0.0248	0.189	0.420
	(0.156)	(0.392)	(0.494)
copd	.	0.0327	0.0780
	(.)	(0.178)	(0.268)
diabetes	0.00823	0.0611	0.146
	(0.0903)	(0.240)	(0.353)
heartdisease	0.00472	0.0396	0.162
	(0.0685)	(0.195)	(0.368)
cancer	0.00230	0.0261	0.0831
	(0.0479)	(0.159)	(0.276)
stroke	0.00121	0.00805	0.0314
	(0.0347)	(0.0894)	(0.174)
obese	0.149	0.237	0.188
	(0.356)	(0.425)	(0.391)
smoke	0.196	0.197	0.0918
	(0.397)	(0.398)	(0.289)
drink	0.0849	0.185	0.273
	(0.279)	(0.388)	(0.445)
ON	0.317	0.335	0.368
	(0.465)	(0.472)	(0.482)
NL	0.0250	0.0305	0.0220
	(0.156)	(0.172)	(0.147)

PEI	0.0143	0.0146	0.0129
	(0.119)	(0.120)	(0.113)
NS	0.0340	0.0369	0.0358
	(0.181)	(0.188)	(0.186)
NB	0.0387	0.0425	0.0369
	(0.193)	(0.202)	(0.189)
QC	0.213	0.200	0.194
	(0.409)	(0.400)	(0.396)
MB	0.0561	0.0523	0.0553
	(0.230)	(0.223)	(0.229)
SK	0.0601	0.0540	0.0554
	(0.238)	(0.226)	(0.229)
AB	0.101	0.0900	0.0747
	(0.301)	(0.286)	(0.263)
BC	0.104	0.121	0.138
	(0.306)	(0.326)	(0.345)
YT	0.0374	0.0226	0.00747
	(0.190)	(0.149)	(0.0861)
income1	0.0741	0.0677	0.138
	(0.262)	(0.251)	(0.345)
income2	0.137	0.143	0.344
	(0.344)	(0.350)	(0.475)
income3	0.167	0.180	0.241
	(0.373)	(0.384)	(0.428)
income4	0.171	0.163	0.134
	(0.377)	(0.370)	(0.340)
income5	0.450	0.446	0.143
	(0.498)	(0.497)	(0.351)
morethanten	0.0470	0.103	0.176
	(0.212)	(0.304)	(0.381)
nineyear	0.0481	0.0193	0.00161
	(0.214)	(0.138)	(0.0402)
employment	0.795	0.750	0.124
	(0.404)	(0.433)	(0.329)
elementary	0.0328	0.0546	0.205
	(0.178)	(0.227)	(0.404)
secondary	0.149	0.156	0.184
	(0.356)	(0.363)	(0.387)
atleastpostsec	0.818	0.789	0.611
	(0.386)	(0.408)	(0.487)

N	9114	20622	9910

mean coefficients; sd in parentheses

Table 5. Logit Model Marginal Effects

	Young	Middle-aged	Seniors
	(1)	(2)	(3)
female	0.0534***	0.0600***	0.0266*
	(0.00923)	(0.00593)	(0.0119)
partnered	0.00163	0.0147***	0.00406
	(0.00723)	(0.00516)	(0.0126)
kids	0.0539***	-0.0335***	-0.0937
	(0.0110)	(0.00536)	(0.0713)
selfhealth	-0.00916**	0.00483**	0.0220***
	(0.00429)	(0.00232)	(0.00611)
doctor	0.0358***	0.119***	0.222***
	(0.00894)	(0.00968)	(0.0246)
asthma	0.0436***	0.0451***	0.0880***
	(0.0128)	(0.00965)	(0.0235)
arthritis	0.0167	0.0497***	0.0549***
	(0.0200)	(0.00728)	(0.0117)
copd	.	0.0737***	0.114***
	(.)	(0.0160)	(0.0227)
diabetes	0.104**	0.115***	0.0848***
	(0.0464)	(0.0142)	(0.0166)
heartdisease	-0.00926	0.0752***	0.0821***
	(0.0430)	(0.0146)	(0.0162)
cancer	0.0456	0.0579***	0.0699***
	(0.0721)	(0.0158)	(0.0210)
stroke	0.187	0.0545*	0.0304
	(0.138)	(0.0280)	(0.0339)
obese	0.0187**	0.0219***	-0.0119
	(0.00950)	(0.00564)	(0.0144)
smoke	-0.0183**	-0.0469***	-0.152***
	(0.00746)	(0.00551)	(0.0173)
drink	-0.0269***	0.00172	-0.0140
	(0.0104)	(0.00551)	(0.0128)
NL	-0.0355**	-0.0560***	-0.171***
	(0.0157)	(0.0103)	(0.0321)
PEI	-0.0237	0.0218	-0.135**
	(0.0215)	(0.0185)	(0.0438)
NS	0.0818***	0.0760***	0.0322
	(0.0220)	(0.0146)	(0.0330)

NB	0.0227	-0.0117	-0.0326
	(0.0164)	(0.00989)	(0.0298)
QC	-0.0481***	-0.0327***	-0.159***
	(0.00873)	(0.00595)	(0.0152)
MB	-0.0281**	-0.0110	-0.152***
	(0.0119)	(0.00919)	(0.0223)
SK	0.00158	-0.0233***	-0.109***
	(0.0126)	(0.00885)	(0.0238)
AB	0.000329	0.00165	-0.143***
	(0.0104)	(0.00771)	(0.0201)
BC	-0.00875	-0.0183***	-0.0691***
	(0.00989)	(0.00652)	(0.0171)
YT	0.0423**	0.0515***	-0.126*
	(0.0195)	(0.0175)	(0.0578)
income1	0.00781	-0.0277***	-0.103***
	(0.0136)	(0.00935)	(0.0239)
income2	-0.00426	-0.00932	-0.0671***
	(0.00951)	(0.00698)	(0.0192)
income3	-0.0164**	-0.00239	-0.0432*
	(0.00830)	(0.00610)	(0.0190)
income4	-0.00279	-0.00570	-0.00994
	(0.00811)	(0.00601)	(0.0213)
morethanten	-0.00477	-0.00329	-0.0507
	(0.0138)	(0.00680)	(0.0147)
nineyear	0.00374	-0.0435***	-0.0456***
	(0.0145)	(0.0138)	(0.132)
employment	0.0119	-0.0272***	-0.144***
	(0.00776)	(0.00542)	(0.0162)
elementary	-0.0297*	-0.0295***	-0.0242
	(0.0154)	(0.00876)	(0.0154)
secondary	-0.0256***	-0.0201***	-0.000956
	(0.00807)	(0.00557)	(0.0150)
N	9114	20622	9910
Log of likelihood	-3932.3933	-11750.37	-6034.0023
Pseudo R2	0.0442	0.0581	0.0602
LR chi2	364.12	1449.14	773.65
Prob > chi2	0.000	0.000	0.000
Predicted Probability	0.1150	0.1533	0.4792

Note: Values in table are marginal effects, with standard errors in parentheses. * indicates significance at the 10% level, ** indicates significance at the 5% level , *** indicates significance at the 1% level

Appendix

Table A1. Original variables from CCHS 2012

Variables	Definitions
ALC_2	Frequency of drinking alcohol
CCC_031	Has asthma
CCC_051	Has arthritis
CCC_091	Has a COPD
CCC_101	Has diabetes
CCC_121	Has heart disease
CCC_131	Has cancer
CCC_151	Suffers from the effects of a stroke
HWTGISW	BMI class. (18 +) / self-report
DHHGAGE	Age
DHH_SEX	Sex
DHHGMS	Marital status
DHHGL12	Number persons < 12 years old in household
EDUDH04	Highest level of education
FLU_162	Had flu shot - last time
GEN_01	Self-perceived health
GEOGPRV	Province of residence of Province of residence of respondent
LBSG31	Employment status
SMK_202	Type of smoker
SDCGRES	Length/time in Canada since immigrant
INCGHH	Total household income from all sources
HCU_1AA	Has regular medical doctor