# Predictors of Influenza Immunization in Persons over Age 65

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***Background:*** **Numerous individual characteristics have been found to be associated with rates of obtaining flu shots. This study creates a predictive model that assesses the relative impact of each of these factors on increasing rates of flu shots in a population.**

***Methods:*** **The Medicare beneficiary survey from 1998 and 1999 was used. Sixteen factors present in 1998 were compared between subjects who did and who did not receive flu shots. Significant factors were then used in a logistic regression to predict the probability of receiving a flu shot in 1998 and 1999.**

***Results:*** **Seven demographic and 7 health status measures were significantly different between subjects who did and who did not receive flu shots in 1998. Logistic regression showed that twelve of these variables were associated with a subject receiving a flu shot in 1998 and explained 11.4% of the variability in who did and who did not receive a flu shot. For the following year, 1999, 7 measures were significantly associated with receiving a flu shot and explained 64% of the variability in who did and who did not receive a flu shot. One variable, if the subject had received a flu shot in 1998, was highly predictive of a subject receiving a flu shot in 1999, explaining 63% of the observed variability in who did and who did not receive a flu shot in 1999.**

***Discussion:*** **The major predictor of getting a flu shot in future years is having received one in the current year (63% of predictive power). Six other behavior and demographic factors increase the predictive power modestly. Programs that target nonrecipients may increase the overall flu shot rates of a community. (J Am Board Fam Pract 2005;18:426–33.)**

Healthy People 2010 has identified a goal of influenza immunization for 90% of high risk persons as a health goal for the nation. Since this goal was first articulated, many programs have been developed to increase the rates of influenza vaccines.[1] Flu shot rates have improved dramatically over the last 10 years although much remains to be done if we are to achieve the goal of 90%.[1] Research has identified numerous characteristics and motivations of persons who do and who do not receive flu shots.[1] Factors that are statistically associated with persons receiving flu shots can be broadly classified into 4 categories: demographic factors,[2–6] health behaviors,[2–4,7,8] health service utilization,[3,10–13] and health care delivery system features.[13–20] A list of some of these factors is presented in Table 1. Because most studies evaluate only a few of these factors, it is difficult to determine the relative impact of any single factor in predicting community flu shot rates compared with the effects of other statistically significant factors.

The purpose of this study is to use the Medicare Beneficiary Survey (MCBS) to create a predictive model that quantifies the relative strength of various factors known to be statistically associated with flu shot rates.

## Methods

### *Medicare Beneficiary Survey*

This investigation was conducted using the MCBS data from 1998 and 1999. The MCBS is a continuous survey of a representative sample of Medicare beneficiaries, including both aged and disabled enrollees. The annual sample includes approximately 13,000 beneficiaries. The survey includes 2 components: (1) detailed interviews with participants 3 times yearly addressing their demographics, health

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**Table 1. Partial List of Factors from the Literature That Are Significantly Correlated with Rates of Influenza Immunizations**

| |
|---|
| Demographic Factors |
| Increases Flu shot rates |
| Higher educational level[2] |
| Increased age[2,3] |
| Male and married[2] |
| Increasing household income[3] |
| Health care worker in family[4] |
| Decreases flu shot rates |
| Spanish-speaking[5] |
| Lack of health insurance[3] |
| African-American[1,3] |
| Hispanic[1] |
| Living alone[6] |
| Not having a driver[6] |
| Health Status and Behaviors |
| Increases flu shot rates |
| Non-smoker[3] |
| Previous vaccination[7] |
| Greater disease burden[2] |
| Fair or poor health status[3] |
| Vigorous exerciser[3] |
| Decreases flu shot rates |
| Previous flu shot side effects[3] |
| Cognitive impairment[3] |
| Being healthier[4,8] |
| Health Service Use |
| Increases flu shot rates |
| Office visit during flu season[9] |
| PCP discussed flu shots[10] |
| 3+ doctors visits in a year[3] |
| Doctor recommendation[11,12] |
| VA patient[11,13] |
| Decreases flu shots |
| Patient of inner city clinic[11,13] |
| Health System Organization |
| Increases flu shot rates |
| Computer reminder to doc[14,15] |
| Walk-in vaccine clinics[13,16,17] |
| Standing vaccine orders[16,17] |
| Mailed patient reminders[16–20] |
| Action-oriented pt reminder[18] |
| Urban practice[19] |

status, and use of health care services; (2) insurance claims data from Medicare showing details of health care utilization and cost. Information from both components of the survey were then reconciled to calculate total health care utilization, cost and utilization for each category of use, and sources of payment for each person who participates in the survey.

The MCBS has been conducted continuously from 1991.[21,22] The survey sample is drawn from Medicare enrollment files. Because Medicare covers over 95% of persons aged 65 or older, the survey is a good representation of this population. The survey gathers information on demographics, cost, and use of services covered by Medicare, and use of services that are not covered (eg, prescription drugs, nursing home care, dental care). Information on use and expenditures is gathered during the in-person interviews, and memory aids are used to ensure completeness and accuracy. Expense data on Medicare-reimbursed services and mortality data are taken directly from Medicare records. Events reported by respondents are linked to claims.[21,22] A detailed description of the methods used to reconcile survey and claims data has been reported elsewhere.[22]

### *Subject Selection*

From the 1998 and 1999 databases, 6110 unique persons were identified who met the eligibility criteria of (1) participating in the survey in both years, (2) were also aged 65 years or older, and (3) were community-dwelling in 1998. Of these subjects, 4876 were Medicare fee-for-service patients and thus had line item claims data available in addition to survey data, and 1234 subjects were HMO members and did not have line item claims data available for analysis of physician visits. Three variables used in the analysis were affected by the missing claims data for the 1234 HMO subjects: total number of physician visits, number of primary care physician visits, and number of specialty physician visits. All other variables were drawn from the survey portion of the MCBS and had data available for the 6110 subjects. The strategy for handling this missing HMO claims data are reported under Logistic Regression below.

### *Variable Identification and Definition*

Variables used in this analysis were a subset of variables that have been identified in the literature as being statistically associated with flu shot rates (Table 1). Sixteen of these variables were also found to be present in the MCBS database and were used for this analysis (Tables 2 and 3). Eleven of the variables were taken directly from the MCBS database, and 5 new variables were calculated from existing database variables. Continuous variables from the MCBS database were age, household income, level of education, and self-reported health status. Dichotomous variables from the MCBS database were gender, African American race, Hispanic ancestry, marital status, living in a metropolitan area, current smoker, HMO enrollment in 1998. The 5 new variables that were created were functional status, disease burden, specialty physician visits, primary care physician visits, and total physician visits.

**Table 2. Demographics of Study Subjects and Significance of Differences between Those Who Did and Those Who Did Not Receive Flu Shots (n = 6110)**

| | Total Population (mean/percent) | Subjects Who Received Flu Shot in 1998 (mean/percent) | Subjects Who Did Not Receive Flu Shot in 1998 (mean/percent) | *t* Test/$\chi^2$, *P* Value |
|---|---|---|---|---|
| Age | 76.1 ± 6.9 | 76.3 ± 7 | 75.4 ± 7 | $t$ = 4.7, <.01 |
| Percent female | 57.7% | 57.1% | 59% | NS |
| Percent African American | 8.6% | 6.2% | 14.1% | $\chi^2$ = 101, <.01 |
| Percent Hispanic | 6.6% | 5.5% | 9.3% | $\chi^2$ = 29, <.01 |
| Household income | $26,522 ± $36,150 | 28,017 ± 30,393 | 23,071 ± 46,873 | $t$ = 4.9, <.01 |
| Highest level of education* | 4.4 ± 2.3 | 4.7 ± 2.1 | 4.0 ± 2 | $t$ = 10.4, <.01 |
| Percent currently married | 52.7% | 55.1% | 47.1% | $\chi^2$ = 33, <.01 |
| Percent living in metro area | 72.1% | 71.3% | 74.2% | $\chi^2$ = 5.6, <.05 |

*1, no schooling; 2, 1–8th grade; 3, 9–12th grade, no diploma; 4, high school graduate; 5, voc tech bus grad; 6, some college, no degree; 7, associates degree; 8, bachelor degree; 9, graduate degree.

Level of education was categorized in the MCBS using the following scale: 1, no schooling; 2, 1st to 8th grade; 3, 9th to 12th grade no diploma; 4, high school graduate; 5, vocational technical business graduate; 6, some college, no degree; 7, associates degree; 8, bachelor degree; 9, graduate degree. In the analysis, it was treated as a continuous variable. Responses for self-reported health status were reported on a 5-point scale: 1, excellent; 2, very good; 3, good; 4, fair; and 5, poor.

The functional status of the patients were classified using a methodology from previous studies of health care delivery to older persons.[21,23] First, the patients function was categorized using 3 different scales: the 5 activities of physical function developed by Nagi, the 6 instrumental activities of daily living, and the 6 activities of daily living. The activities described by Nagi are stooping, crouching, or kneeling; lifting or carrying objects up to 10 pounds; lifting arms above shoulder height; grasp-

**Table 3. Health Status and Health Behaviors of Subjects Who Did and Did Not Receive Flu Shots (n = 6110)**

| | Total Population (mean/percent) | If Received Flu Shot in 1998 (mean/percent) | If Did Not Receive Flu Shot in 1998 (mean/percent) | *t* Test, *P* Value |
|---|---|---|---|---|
| Percentage of current smokers | 11% | 8.9% | 15.7% | $\chi^2$ = 61, <.01 |
| Number of chronic diseases (max = 15)* | 2.3 ± 1.6 | 2.4 ± 1.6 | 2.0 ± 1.5 | $t$ = 10.4, <.01 |
| Level of disability† | 2.5 ± 1.1 | 2.6 ± 1.1 | 2.5 ± 1.1 | $t$ = 3.1, <.01 |
| Self-reported health status‡ | 2.7 ± 1.1 | 2.7 ± 1.1 | 2.7 ± 1.1 | NS |
| Saw any physician in 1998 (non-HMO)§ | 90% | 94% | 83% | $\chi^2$ = 135, <.01 |
| No. of total physician claims in 1998 (non-HMO)§ | 27 ± 32 | 30 ± 33 | 20 ± 30 | $t$ = 94, <.01 |
| Saw pcp in 1998 (non-HMO)§ | 74% | 78% | 65% | $\chi^2$ = 83, <.01 |
| No. of primary care physicians claims in 1998 (non-HMO patients)§ | 9 ± 12 | 9.9 ± 13 | 6.5 ± 11 | $t$ = 91, <.01 |
| Saw specialist in 1998 (non-HMO patients)§ | 84.4% | 88% | 75% | $\chi^2$ = 136, <.01 |
| No. of specialist claims in 1998 (non-HMO patients)§ | 18 ± 27 | 19 ± 27 | 14 ± 25 | $t$ = 7.2, <.01 |
| HMO enrollment in 1998 | 20.3% | 21% | 18.5% | $\chi^2$ = 5.2, <.05 |

*High blood pressure, previous myocardial infarction, angina/ischemic heart disease, stroke, cancer, diabetes, arthritis, osteoporosis, broken hip, psychiatric illness, Alzheimer disease, Parkinson disease, chronic obstructive pulmonary disease/emphysema, paralysis, amputation.
†1, none; 2, nagi limitation; 3, iadl limitation; 4, adl limitation.
‡1, excellent; 2, very good; 3, good; 4, fair; 5, poor.
§4876 patients were non-HMO patients and had line item claim data available.

ing small objects; and the ability to walk 2 to 3 blocks. Respondents who reported no difficulty at all were categorized as being able to perform the activity; those reporting any level of difficulty at all or not being able to perform the activity were coded as having a limitation in functioning. The instrumental activities of daily living included doing light housework, doing heavy housework, shopping, managing money, preparing meals, and using the telephone. The 6 activities of daily living (ADLs) included eating, dressing, bathing, transferring from bed or chair, using the toilet, and walking.

An overall score for functional status was then computed from the 3 scales. Each subject was categorized into one of 4 functional categories using a methodology previously described by Lubitz.[21,23] The 4 categories were: no limitation, limitation with only NAGI functions but without limitation of IADLs or ADLs, limitation with IADLs but without limitation of ADLs, and limitation of ADLs.[10,11]

Disease burden was also computed from the survey portion of the MCBS. On the MCBS, subjects are asked a series of yes/no questions on the presence of a variety of chronic diseases. The calculation of disease burden was computed as follows. For each disease that the subject reported as being present, the subject was given 1 point. The subjects had a total possible disease burden score of 15 if all the diseases from the following list were present: high blood pressure, previous myocardial infarction, angina/ischemic heart disease, stroke, cancer, diabetes, arthritis, osteoporosis, broken hip, psychiatric illness, Alzheimer disease, Parkinson disease, chronic obstructive pulmonary disease/emphysema, paralysis, amputation. No adjustments were made for the severity of individual diseases.

Physician visit rates were computed from the claims data portion of the MCBS. Each claim submitted to Medicare has a physician specialty code associated with the claim. Primary care physicians included general practitioners, family physicians, and general internists, as defined by the CMS provider specialty codes used on the HCFA 1500 claims submission form. Specialty physicians included the following: general surgery, allergy/immunology, otolaryngology, anesthesia, cardiology, dermatology, gastroenterology, neurology, neurosurgery, obstetrics/gynecology, ophthalmology, orthopedic surgery, plastic and reconstructive surgery, physical medicine and rehabilitation, psychiatry, colorectal surgery, pulmonary disease, thoracic surgery, urology, pediatric medicine, nephrology, hand surgery, infectious disease, endocrinology, podiatry, multispecialty clinic, pain management, vascular surgery, cardiac surgery, addictive medicine, critical care medicine, hematology/oncology, maxillofacial surgery, neuropsychiatry, medical oncology, surgical oncology, radiation oncology, gynecological oncology, and clinical psychology.

### *Logistic Regression*

Patients were categorized into 2 groups based on whether they did or did not receive a flu shot in 1998. Using logistic regression, a model using the sixteen variables discussed above was tested for the strength of their association with receipt of a flu shot. The variables included in the analysis were: age, gender, Hispanic ancestry, African American race, level of education, martial status, household income, living in an urban versus rural area, self-reported health status, smoking status, number of chronic diseases, level of physical functioning, number of primary care physician insurance claims in 1998, and number of specialty physician insurance claims submitted in 1998, number of total physician claims in 1998, and enrollment in an HMO. Subjects with missing claims data were categorized as having zero physician visits when they were entered into the logistic regression.

A second logistic regression analysis was performed to assess the strength of the variable's ability to predict the receipt of an influenza immunization the following year, 1999. All fifteen variables from the first logistic regression were included in the model. This second regression was then repeated including all fifteen variables from the first logistic regression and adding a variable on flu shot status in 1998.

## Results

From the Medicare beneficiary database, 6110 subjects were identified who met the inclusion criteria outlined in Methods. In 1998, 4272 (70%) of the subjects received a flu shot, 1820 (30%) did not receive a flu shot, and flu shot data were missing for 18 subjects. In 1999, 4331 (71%) subjects received a flu shot, and 1779 (29%) did not. Of the 6110 subjects that had data for both 1998 and 1999, 4272 received a flu shot in 1998, and of these, 3988 received a flu shot in 1999 (93.4%). Of the 1820 that did not receive a flu shot in 1998, 332 did receive a flu shot in 1999 (18%).

### *Demographics*

The demographics of the 6110 subjects are presented in Table 2. There was a significant difference in 7 of 8 demographic parameters between those subjects who did and those who did not receive a flu shot in 1998 (Table 2). Specifically those subjects who received a flu shot were older, more likely to be married, have higher household incomes, have higher levels of education, be less likely to live in a metropolitan area, were less likely to be African American, and were less likely to be of Hispanic ancestry. Gender was not significantly associated with receipt of a flu shot in 1998.

### *Health Status, Health Behaviors, Disease Burden, and Health Care Utilization*

Eight measures of health status, health behavior, disease burden, and health care utilization of the 6110 subjects are presented in Table 3. All measures except one, self-reported health status, were significantly different between subjects who did and those who did not receive a flu shot in 1998. Subjects who received a flu shot were more likely to be nonsmokers, to have higher disease burden, to have higher levels of disability, to have more visits to primary care physicians, to have more visits to specialty physicians, and to be an HMO member.

### *Factors Associated with Influenza Immunization during the Same Year (1998)*

The fifteen of sixteen variables that were significantly different between subjects who did and did not receive flu shots (excludes gender) were tested in the logistic regression model. Twelve variables were significantly associated with rates of flu shots during 1998 (Table 4). These twelve variables accounted for 11.4% of the variability in who received flu shots (Nagelkerke R square = 0.114) and predicted the flu shot status of 72% of the subjects. Variables that increased the likelihood of having received a flu shot were increasing disease burden, increasing level of education, increasing age, increasing household income, increasing numbers of primary care physician claims, being an HMO member, being married, and increasing numbers of total physician claims. Variables that decreased the

**Table 4. Logistic Regression of Factors Significantly Associated with Flu Shot in the Current Year (1998)*†**

| Variable | Beta | Wald Statistic | *df* | *P* Value |
|---|---|---|---|---|
| Constant | 4.829 | 110 | 1 | <.01 |
| Disease burden | −0.187 | 80 | 1 | <.01 |
| Level of education | −0.127 | 59 | 1 | <.01 |
| African American | −0.699 | 49 | 1 | <.01 |
| HMO member | 0.475 | 34 | 1 | <.01 |
| Current smoker | −0.471 | 27 | 1 | <.01 |
| Married | 0.296 | 21 | 1 | <.01 |
| Age | −0.20 | 19 | 1 | <.01 |
| Urban resident | −0.270 | 15 | 1 | <.01 |
| No. of primary care provider claims | −0.014 | 12 | 1 | <.01 |
| Hispanic ancestry | −0.368 | 11 | 1 | <.01 |
| Total no. of physician claims | −0.005 | 9 | 1 | <.01 |
| Household income | 0.00 | 6 | 1 | <.05 |

*Flu shot: yes = 0, no = 1; for all categorical variables (African American, Hispanic ancestry, smoking, married?, HMO membership, living in urban area) yes = 0, no = 1.
†Variables not statistically significant in the model: self-reported health status, level of disability, and number of specialist physician claims.

rate of flu shots were being African American, being of Hispanic ancestry, being a current smoker, and being an urban resident. Variables that were not associated with flu shot rates were self-reported health status, level of disability, and number of specialist physician claims.

### *Predictors of Influenza Immunization in Future Years (1999)*

The same fifteen variables used in the previous regression model were tested in a regression model to predict flu shot status in 1999. Of these, twelve were significantly associated with rates of future flu shots during 1999 (Table 5). These twelve variables accounted for 11.5% of the variability in who received a flu shot in 1999 (Nagelkerke R square = 0.115) and correctly predicted the flu shot status of 72.4% of the subjects. Variables that increased the likelihood of having received a flu shot in 1999 were: (1) increased disease burden, (2) increasing level of education, (3) increasing age, (4) increasing household income, (5) increasing number of primary care physician claims submitted, (6) increasing number of total physician claims submitted, (7) being an HMO member, (8) being married, and (9) being an urban resident. Factors associated with

**Table 5. Logistic Regression of Factors (excluding flu shot status in 1998) Significantly Associated with Flu Shot in the Subsequent Year (1999)*‡**

| Variable | Beta | Wald Statistic | *df* | *P* Value |
|---|---|---|---|---|
| Disease burden | −0.169 | 65 | 1 | <.01 |
| Level of education | −0.122 | 53 | 1 | <.01 |
| HMO member in 1998 | 0.600 | 52 | 1 | <.01 |
| African American | −0.686 | 47 | 1 | <.01 |
| No. of primary care claims | −0.023 | 29 | 1 | <.01 |
| Current smoker | −0.479 | 28 | 1 | <.01 |
| Married? | 0.283 | 19 | 1 | <.01 |
| Age | −0.018 | 15 | 1 | <.01 |
| Hispanic ancestry | −0.394 | 12 | 1 | <.01 |
| Urban resident | −0.240 | 12 | 1 | <.01 |
| Household income | 0.00 | 7 | 1 | <.05 |
| Total no. of physician claims | −0.004 | 6 | 1 | <.05 |
| Constant | 4.635 | 101 | 1 | <.01 |

*Flu shot: yes = 0, no = 1; for all categorical variables (African American, Hispanic ancestry, smoking, married?, HMO membership, living in urban area) yes = 0, no = 1.
‡Variables not statistically significant in the model: self-reported health status, level of disability, and number of specialist physician claims. R square of model = 0.115.

decreasing flu shot rates were (1) being African American, (2) being of Hispanic ancestry, and (3) being a current smoker. Three factors were not associated with flu shot rates in 1999: (1) self-reported health status, (2) number of specialty physician claims submitted, and (3) level of disability.

Sixteen variables were tested in this logistic regression model: the previous fifteen variables plus flu shot status in 1998. Of these, 7 were significantly associated with rates of future flu shots during 1999 (Table 6). These 7 variables accounted for 64% of the variability in who received flu shots (Nagelkerke R square = 0.64) and correctly predicted the flu shot status of 90% of the subjects. Variables that increased the likelihood of having received a flu shot were: (1) receiving a flu shot in 1998, (2) increasing numbers of primary care physician claims, (3) being an HMO member, (4) increasing level of education, and (5) increasing disease burden. Variables that decreased the rate of flu shots were: (1) being African American and (2) being a current smoker. Variables that were not associated with future flu shot rates were total number of physician claims, number of specialist physician claims, martial status, age, household income, self-reported health status, Hispanic ancestry, level of disability, and living in an urban area. The strongest predictor of future flu shots (in 1999) was having obtained a flu shot the previous year, in 1998 (Nagelkerke R square = 0.63).

**Table 6. Logistic Regression of Factors (including flu shot status in 1998) Significantly Associated with Flu Shot in the Subsequent Year (1999)*†**

| Variable | Beta | Wald Statistic | *df* | *P* Value |
|---|---|---|---|---|
| Flu shot in 1998 | 4.073 | 2101 | 1 | <.01 |
| No. of primary care provider claims in 1998 | −0.022 | 24 | 1 | <.01 |
| HMO member in 1998 | 0.470 | 16 | 1 | <.01 |
| Level of education | −0.075 | 12 | 1 | <.01 |
| African American | −0.382 | 6 | 1 | <.05 |
| Current smoker | −0.321 | 6 | 1 | <.05 |
| Disease burden | −0.059 | 4 | 1 | <.05 |
| Constant | −4.661 | 124 | 1 | <.01 |

*Flu shot: yes = 0, no = 1; for all categorical variables (African American, Hispanic ancestry, smoking, married?, HMO membership, living in urban area) yes = 0, no = 1.
†Variables not statistically significant in the model: total number of physician claims, marital status, age, Hispanic ancestry, household income, self-reported health status, level of disability, living in an urban area, and number of specialist physician claims. R square of model = 0.64.

## Discussion

Numerous factors have been found to be associated with flu shots rates in subjects over the age of 65. Many of the demographic and health care utilization factors found from the literature to be associated with differences in flu shot rates were also found to be significantly associated with flu shot rates in this model. Most of the previous research, however, focused on which factors were associated with flu shot status in the same year. Less analysis has occurred with regard to the prediction of future rates of immunization against influenza. In our analysis, more factors were associated with flu shot rates in the current year than were predictive of flu shot status in the subsequent year.

The most significant single factor for predicting that a subject will obtain a flu shot next year is whether they received a flu shot this year. This predictive model can then be further refined by adding a variety of demographic and health utilization factors including number of primary care physician visits, HMO membership, level of education, race, smoking status, and disease burden.

The most significant challenge to increase influenza immunization status of seniors is to get people to get their first flu shot. Once they have received a flu shot, they are highly likely to repeat this in subsequent years. The value of the other factors that predict future flu shot status is they allow a more focused tailoring of any intervention. For instance, because people with lower educational levels are less likely to obtain flu shot, all public health messages must be kept simple. In addition, it would make the most sense to have targeted efforts at persons who are either African American or who are current smokers. In addition, everyone should be reminded to visit their primary care physician because this is likely to increase the flu shot rates, and people over 65 should be reminded to obtain a flu shot even if their health is good.

One successful program for improving the flu shot status for a general population of seniors has been developed by Nichol at the Minneapolis Veterans Affairs.[16,17] In her model, several critical features were a part of the intervention: mailed reminders for the patients, walk-in flu shot clinics, and standing orders.[16,17] A second program that has been successful for minority populations was developed using a senior center in Seattle.[8] In this program, seniors from the targeted ethnic community volunteered to call members of their ethnic community to encourage them to come to the senior center to obtain a flu shot. Whereas this intervention worked to improve flu shot rates for seniors who had and who had not received a previous flu shot, the results were particularly pronounced for patients who had not received a flu shot in the past.

In summary, this model accurately predicts the future flu shot status for 90% of subjects and explains 64% of the variability in who does and who does not get a flu shot. A single factor results in most of the predictive power: did the person receive a flu shot last year. Predictive accuracy of the model is improved by adding several demographic and health behavior factors.

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