Flu Shots, Mammogram, and the Perception of Probabilities

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Abstract

We study individuals' decisions to decline or accept preventive health care interventions such as flu shots and mammograms. In particular, we analyze the role of perceptions of the effectiveness of the intervention, by eliciting individuals' subjective probabilities of sickness and survival, with and without the interventions. Respondents appear to be aware of some of the qualitative relationships between risk factors and probabilities. However, they have very poor perceptions of the absolute probability levels as reported in the epidemiological literature. Perceptions are less accurate if a respondent is female and has no college degree, and deteriorate after age 50. Perceived probabilities significantly affect the subsequent take-up rate of flu shots and mammograms.

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1. Introduction

Preventive health care is at the heart of many suggested reforms to control costs and improve the efficiency of health care. While preventive care obviously cannot eliminate death, it can help to extend life and avoid or delay the occurrence of diseases. Making decisions about using preventive care, however, can be very difficult. Individuals typically know little about the magnitude of the risk that they face and about the potential benefits of preventive care.

This paper examines the choices that people make about using preventive care, focusing on individuals' perceptions of probabilities of disease and death, and the effectiveness of interventions. We also compare the subjective probabilities with estimates of actual probabilities found in the epidemiological literature, and analyze how the discrepancies vary with observed characteristics like health status and information provided. Finally, we investigate the relationship between perceived probabilities and take-up rate of flu shots and mammograms.

There are several key differences between the previous literature and the present paper. First, we measure individuals' perceptions of risk in the form of subjective, numerical probabilities. Numerical probabilities not only have more predictive power than more qualitative expectations data (Juster, 1966), but also allow to better evaluate the internal consistency and external validity of responses. Second, while the previous literature has primarily focused on a single intervention, we consider multiple preventive care measures for each individual. This allows us to analyze behavioral differences of individuals across preventive interventions. Third, we compare the effects of subjective and individualized epidemiologically predicted risks on behavior, for a general population sample that is not limited to the elderly population. Fourth, we explore several survey methods of eliciting subjective estimates of risk.

We find that a majority of respondents answer probability questions in a way consistent with basic probability concepts. Moreover, they appear to be aware of some of the qualitative relationships between risk factors and probabilities. However, they have very poor perceptions of the absolute probability levels as reported in the epidemiological literature. Perceptions are less accurate if a respondent is female and has no college degree. Moreover, the accuracy of perceptions strongly deteriorate after age 50. Perceived probabilities strongly affect the subsequent take-up rate of flu shots and mammograms and are far better predictors of take-up than their epidemiological counterparts. Our results indicate that probability perceptions are key to understanding behavior regarding preventive care and designing effective preventive health care programs.

The paper proceeds as follows. Section 2 discusses literature on preventive health care and subjective probabilities. Section 3 describes the institutional details of the flu shot and mammogram programs in the Netherlands. Our survey and data collection are described in section 4. Section 5 considers the epidemiological literature on the relevant probabilities of disease and death. Section 6 presents our empirical results and section 7 concludes.

2. Preventive Health Care and Subjective Probabilities

From an economic perspective the decision to take up preventive care is an investment decision. Loosely speaking, such an investment is worthwhile if the expected present value of the reduction in illness and the probability of death is greater than the opportunity costs of the intervention; see, Grossman (1972), Cropper (1977), Hey and Patel (1983), Dardonini and Wagstaff (1987), Selden (1993), and Chang (1996)) for the formalization of these notions.

Whether people ultimately decide to invest in preventive care is largely an empirical matter. Kenkel (1994) finds that the probability that women will have mammograms and pap smears increases with schooling and insurance coverage and decreases with age. Mullahy (1999) finds that schooling and insurance coverage are important determinants of getting a flu shot. The interpretation of the effects of insurance coverage may reflect price effects, access to health care in general, or some 'adverse' selection (people with a high demand for health care are more likely to have insurance). Belkar et al. (2006) suggest that awareness plays a key role in determining who uses preventive care and that failing to account for this awareness can influence the measurement of other effects. Trivedi et al. (2008) find that co-pays also play an important role. Insurance companies that introduce co-pays for mammograms see decreases in the percentage of women participating in these interventions.

Central in any analysis of preventive health care are the probabilities of illness and death and the effectiveness of prevention. Typically, these parameters are assumed to be known by the individual. However, individuals' perceptions of the risks they face may differ wildly from the true underlying risks and are likely to be better predictors of individual behavior.

The use of subjective probabilities in economics was first proposed by Juster (1966). The standard question takes the form: "What is the percent chance that you will choose X" or that "X will happen". Juster shows the superior informational content of such probabilities over qualitative response scales (like "very likely", "probable", "rarely") when trying to predict consumer choice. Since the early 1990s, such subjective probabilities have become an integral part of major household surveys around the world. Their validity and predictive power has been shown in a wide range of contexts, including retirement behavior (Hurd and McGarry, 1995), bequests (Hurd and Smith, 2002), income expectations (Dominitz and Manski, 1997), contraceptive choice (Delavande, 2006), individual survival (Hurd and McGarry, 2005) and Gan, Hurd and McFadden, 2003), health risks of smoking (Khwaja, Silverman and Sloan, 2009), and life events of adolescents (Bruine de Bruin et al., 2007a).

The existing literature that examines the relationship between risk perception and the use of preventive care has typically used qualitative risk perceptions and samples of limited size. Salant et al. (2006), for example, find that 33 women who are objectively assessed to be high risk are unlikely to feel that they are at high risk and are skeptical of the effectiveness of prevention. Lipkus et al. (2000) find that information on both absolute risk and relative risks are necessary to encourage participation in prevention. Satterfield et al. (2000) consider the relationship between perceived risks and behaviors in the case of osteoporosis. They find that people who are more informed about recommendations regarding various preventive behaviors are more likely to follow those recommendations. (They also asked about risk using categorical responses but did not relate that to behavior.) Finally, Peters et al. (2006a) examine the relationship between worry, risk perceptions, and intentions to reduce medical errors in a small convenience sample. They find that worry matters more than risk perceptions, but focus on intentions to act (not on actual behavior) and use categorical representations of risk (not numerical subjective probabilities).

3. The Dutch Flu Shot and Mammogram Program

The Netherlands has mandatory health insurance for all residents. Each person is required to purchase a basic health insurance package from a private insurance company, but this basic insurance package typically does not cover preventive care. Individuals have the opportunity to change insurance companies at the beginning of each year, which discourages insurance companies from investing in prevention. While the contents of the basic health insurance package are mandated by law, preventive care programs are currently not included. It is possible to buy supplementary insurance that covers additional services not covered by the basic insurance package.

Instead, the Dutch government funds some preventive care through the National Institute of Public Health and the Environment (RIVM). Preventive care, in the case of cancer screening can be expected to have benefits long after a one-year insurance contract ends and, in the case of influenza vaccines, has significant public health benefits. This paper considers two of the most important preventive care measures available through RIVM to adults in the Netherlands: flu shots and mammograms.[1]

First, RIVM provides influenza vaccines for everyone over the age of 60 (65 before 2008) and to certain high risk groups. In a typical year, roughly 5 to 20 percent of the population can be expected to catch influenza (or the flu).[2] For most people symptoms last 1 to 2 weeks. However for the elderly (ages 60 and up) and at risk populations, such as those with heart disease, pulmonary problems, or diabetes, influenza can lead to death. Mortality due to influenza for the elderly is approximately 130 per 100,000 people, 100 times mortality due to influenza for adults under the age of 50; see Thompson et al., 2003). Each year influenza vaccines are developed to prevent the strains of influenza expected to be most likely in the coming year. Through RIVM's program, general practitioners send letters in the Fall to all of their patients who are eligible for these free flu shots inviting them to come in for their flu shot. Outside of this age range people can still receive a flu shot from their doctor. In this case the out-of-pocket price will depend on their specific health insurance package.

Second, to increase the chances of identifying breast cancer at an early stage, RIVM provides mammograms to women between the ages 50 and 75. One in ten Dutch women will get breast cancer at some point in their life. Important risk factors for breast cancer include current age, age that menstruation began, age of first live birth, the number of relatives who had breast cancer, and the number of past breast biopsies. Annual mammograms can reduce the probability of death from breast cancer by 15 percent; cf. Gotzsche and Nielsen (2006). RIVM funds mammograms every two years for women between the ages of 50 and 75, which leads to a slightly lower decrease in the probability of death. Women receive a letter from the RIVM directly inviting them to have a mammogram. Women outside of this age group may still receive mammograms, but the out-of-pocket price will depend on their specific insurance package.

We also consider pap smears which are provided every five years to women between the ages of 30 and 60. According to a recent article in the New England Journal of Medicine,[3] paps smears are one of the most effective preventive care interventions available. Annual pap smears can reduce cervical cancer mortality by at least 94%. Early detection of benign abnormalities can even prevent cells from becoming cancerous. In the Netherlands, pap smears are given once every five years. At this frequency, mortality

[1] Pap smears are also provided by RIVM. Other common preventive care measures, such as colonoscopies and Prostate-Specific Antigen (PSA) tests are not currently provided on a systematic basis either through the basic insurance packages or through the RIVM.

[2] By flu, we mean actual flu or influenza, not a cold or stomach flu. Symptoms of influenza include rapid onset, aching muscles all over the body, a high temperature and usually a pounding headache.

[3] Sawaya et al. (2001)

can be reduced by 83%. As with mammograms, women receive a letter from the RIVM directly inviting them to schedule an appointment for a free pap smear with their general practitioner. In the case of pap smears, women may be able to receive pap smears more often or before reaching age 30; the price will depend on their insurance.

In addition to these three publicly funded prevention programs, we consider two other preventive care measures. These provide an interesting contrast to the government funded programs because of the different incentives for individuals to use them, including the fact that they may not need to see a doctor.[4] The first is daily low dose aspirin for the prevention of cardiovascular disease. Low dose aspirin has been shown to promote both the primary and secondary prevention of cardiovascular disease, preventing both the development of cardiovascular disease and negative outcomes such as heart attacks and strokes. Second, we consider screening for sexually transmitted diseases amont individuals under the age of 40. These preventive care interventions provide three intervention opportunities for men and five for women.

4. The Survey

Our primary data source is the LISS Panel, a random representative sample of Dutch individuals who participate in a monthly Internet survey. It contains information on a large variety of domains including demographics, housing, work and time use, happiness and health, and financial decisions.[5] The LISS Panel has two important advantages that make it particularly valuable for this research. First, it is possible to randomize the content and format of questions, for example to compare the effects of different wordings of questions. Second, it is possible to follow up with the same participants at a later date.

For this paper, panel members were asked additional questions at two different points in time. The largest part of the data used in this paper was collected in September 2008. Respondents were asked a series of questions mainly on past take up of flu shots, mammograms, and pap smears, and various related perceived probabilities. Previous research on the elicitation of subjective probabilities shows that survey modes can affect responses; see e.g. Woloshin et al., 2000. We therefore use three different survey modes, randomly assigned to respondents: an open-ended probability question, (with a number between 0 and 100 to be typed in), a linear probability scale (with a number between 0 and 100 to be selected using the

[4] It is recommended that people begin daily low dose aspirin after speaking with their doctor, however given the prominence of this intervention in the media, it is possible that some people would choose to begin such therapy on their own.
[5] Those who do not have access to the internet are provided with a "set top box" allowing them to access the internet through their television.

mouse) or the linear probability scale with magnifier (magnifying a part of the scale around the cursor location). Following the Survey of Economic Expectations, we introduce the subjective probability questions with a brief description of probabilities; see Manski (2004). In addition, individuals' numeracy and 'probability literacy' was assessed following Peters et al. (2006b). Individuals were randomly assigned to receive this numeracy assessment at the beginning or the end of the survey. In addition, we asked individuals who had had flu shots, mammograms or pap smears about their monetary and time costs related to the use of prevention. For those who did not participate, we asked about their expected monetary and time costs. Monetary costs included both the cost of the intervention and any travel costs. We also asked a number of questions that might provide information about people's motivations for participating or not participating in preventive care. Individuals were asked whether someone they knew well had died of influenza or breast cancer. This question was intended to identify whether personal experience with a disease increases an individual's perception of their risk or their likelihood of participation. Furthermore, we asked individuals to rate, on a scale from 1 to 5, whether they agreed with a number of statements that captured many of the reasons why an individual might not have a flu shot or mammogram. For example, whether they had time to participate, whether they thought the procedure was unpleasant, and whether they knew anything about the preventive care measure. The questions provide one qualitative measure of an individual's perception of their risk: whether they think that they are at high risk for each disease.

In January 2009 respondents were approached again, and asked whether they had received a flu shot in October 2008 or thereafter. Individuals were asked to consider actual influenza, as described in footnote 2.

Table 1 reports a number of descriptive statistics. Almost one quarter of respondents received a flu shot in the preceding year, nearly 40% of women have had a mammogram in the past two years, and 60 %have had a pap smear in the past 5 years. Participation rates are even higher among age groups that are targeted to receive these interventions.

The actual time and monetary costs reported by individuals who used preventive care were lower than the costs perceived by those who did not use preventive care. The average expected monetary cost for people who received a flu shot was 0.93 Euro, while the expected costs for people who did not receive a flu shot was 26.47 Euro. For mammograms, the actual and expected monetary costs are 2.13 Euro and 74.84 Euro. For pap smears, the actual and expected monetary costs are 2.23 Euro and 37.64 Euro. These differences are both statistically and economically significant. The differences in the time costs are less extreme: 19.7 minutes versus 34.88 minutes for flu shots, 46.46 minutes versus 66.93 minutes for mammograms, and 35.45 minutes versus 42.34 minutes for pap smears. There are three possible explanations for higher expected than actual costs. First, the difference may be an accurate description of reality; people with higher costs may be less likely to participate. Second, individuals with higher perceived costs may be less likely to participate. Finally, there may be some sort of justification bias. People who choose not to participate may report higher expected costs as a justification for their decision not to participate; similarly, people who did participate may report lower costs than they actually incurred to justify their decision.

5. **Epidemiological Measures of Health Risks**

Using epidemiological results is it possible to impute an individual's risk of developing various diseases and of dying from those diseases. For many diseases, including breast cancer and heart disease, there are risk prediction calculators based on epidemiological research available on the internet. Individuals can answer questions about their risk factors and receive predictions about their risk of developing various diseases; see http://www.yourdiseaserisk.com for an example. While these online calculators often only provide relative risk information in qualitative terms, such as “well below average”, “below average”, “average”, “above average”, “well above average” risk, there is a statistical model behind these calculators that can be used to calculate a numerical risk level.

Perhaps the most famous risk calculator is the Framingham Risk Assessment tool,[6] which can be used to calculate your risk of developing heart disease. This model was developed using the Framingham Heart Study data. This study empaneled much of the population of Framingham, Massachussets and has followed this population and their offspring for over 50 years. Using this data, it was possible to identify risk factors that were correlated with the five year probability of developing heart disease.[7] The Framingham Risk Assessment tool calculates individual risk as a function of age, gender, blood pressure, total cholesterol, and whether the individual is a smoker.

Another famous risk calculator is the Gail Model (Gail et al., 1989), which can be used to calculate a woman's risk of developing breast cancer. This model used the Breast Cancer Detection Demonstration Project to identify risk factors that predict the probability of developing breast cancer in the next five years. Important risk factors for breast cancer include current age, age that menstruation begins, age of first live birth, the number of relatives who had breast cancer, and the number of past breast biopsies. Given an individual's underlying risk for developing breast cancer, we can also calculate the individual's probability of dying from breast cancer in the next five, ten or twenty years, with and without annual mammograms. This is a function of the individual's risk of developing the disease and the age

[6] Wilson et al. (1998)
[7] Ten year probabilities are roughly equivalent to two times the five year probability.

specific survival probabilities. Age specific survival rates from the Surveillance Epidemiology and End Results (SEER) database were used. The Gail Model was developed using a population who received annual mammograms. Annual mammograms have been found to cut the risk of death by 15 percent; see Gotzsche and Nielsen (2006). The Gail Model has been validated numerous times, both in the US and Europe, and has been shown to be a good predictor of risk; see, for example, Rockhill et al. (2001), Dicarli et al. (2006), and Thomsen et al. (2002). We choose this model because of its prominence and because most risk factors could be identified in our survey data. Other risk factors, such as breast density or genetic marker such as BCR1 and BCR2, may be important predictors of risk but few women would be able to accurately report information on these factors in survey data.

For influenza, the epidemiological literature calculating the risk of influenza and death from influenza is less precise. The primary problem is that it is very difficult to measure influenza rates in the population. Many people who report having the flu, actually have a cold or a stomach virus and not influenza, and many people who have influenza never report it to doctors. Influenza can be detected with blood tests or using nasal specimens. We were unable to find a study that calculates influenza risk as a function of any risk factors. However, we were able to find the average mortality rate by age groups due to influenza for the 1990-1991 through 1998-1999 seasons. We use this measure as the probability of dying from the flu. Because of the difficulties associated with identifying influenza, and because many influenza related deaths can be reported to be due to other co-morbidities, there are three measures of the influenza death rate. The first and most conservative measure counts only laboratory confirmed influenza deaths. The second measure adds deaths attributed to respiratory and circulatory problems that are influenza related. The third and most liberal measure includes all causes of death that can be attributed to influenza. Table 2 shows the annual mortality rates by age used for our predicted risk of death as calculated by Thompson et al. (2003). Mortality rates increase dramatically with age, for both the liberal and the conservative estimates, individuals over the age of 65 are one hundred times more likely to die from influenza than individuals between the ages of 5 and 49. Of course, the actual risks associated with influenza evolve as a smooth function of age.

The most liberal estimates of the death rate from influenza have been used historically by many studies. However, these results are based on increases in all causes of death for people who have influenza. If a person who has influenza or has recently had influenza dies in a car accident this could be counted as an all-cause influenza related death. The most conservative estimates underestimate the mortality rate due to influenza, since influenza is more fatal for people who have co-morbidities such as respiratory or circulatory health problems and the cause of these deaths may be reported as respiratory. Therefore the moderate estimate of the death rate is our preferred estimate.

6. Empirical Results

6.1 The Accuracy of Perceived Probabilities

The data described in the previous two sections allow us to compare individuals' perception of the risk to their actual risk, as determined by epidemiological models. Tables 3, and 4 present the comparions. For influenza we see that people report a high likelihood of getting the flu without a flu shot, the mean subjective probability of getting the flu in the coming flu season is 31%; the median is lower at 21%. With a flu shot these numbers drop to 20% and 10% respectively. These numbers are higher than we might expect; in a typical flu season less 20% of the population gets influenza; see Hueston (2004) and Govaert (1998). One possible explanation for this overestimate is that people often use the word flu to refer to other illnesses. While we do state at the beginning of the survey that we are interested in actual influenza and provide a definition, some people may not realize the distinction.

The mean subjective probability of getting breast cancer in 5 years is 19% and 22% in ten years. Again these amounts are higher than the medians, at 10% and 14%, respectively. More striking is the difference between the subjective probabilities and those found using the Gail Model. The Gail Model implies that the average risk of being diagnosed with breast cancer in the next 5 years is approximately 1%, and 1.9% in ten years. Perhaps, some of this overestimation of risk is due to a prominent public service message in the Netherlands which stated that 1 in 10 women would get breast cancer in their lifetime.

The mean subjective probability of getting heart disease in 5 years is 16% and 19% in ten years. Again these amounts are higher than the medians, both around 10%. As with influenza and breast cancer, individuals overestimate the risk of heart disease, however the overestimation is not as great. According to the Framingham model, the mean risk is 6.4 % in 5 years, and doubles in 10 years. There may be less overestimation of the risk of heart disease because the epidemiological risk are not as small. As will be discussed below, individuals have a tendancy to overestimate very small probabilities more, but this overestimation is less extreme with more moderate probabilities.

Table 4 examines the subjective probability of dying from each of the various diseases. For influenza related deaths individuals were asked to report the probability of death if they were to get influenza; combining this with their subjective risk of getting the flu we can calculate the unconditional probability of dying from the flu. Table 4A reports the unconditional probabilities. Death from influenza, even for the elderly, is a very rare occurrence; the highest epidemiological predictions indicate that mean objective probability of death from influenza in a given year in our sample is 0.044% without a flu shot and 0.009% with a flu shot, more than 100 times less than the mean reported subjective probabilities (8.5% and 6.7% respectively). Similarly for breast cancer, the average subjective probabilities of death are bout than 100 times those predicted by the epidemiological models. Again with heart disease, individual overestimate their risk of death less than with influenza and breast cancer.

The discrepancies between the two sets of probabilities are in line with previous research on probability perceptions in the the health doimain. Overestimation of health risks has been found for breast cancer (Skinner , 1998), and smoking-induced lung cancer (Viscusi, 1992). Bruine de Bruin et al. (2007b) find that teenagers vastly overestimate the probability of death.

For both influenza and breast cancer we also can compare the effectiveness of the prevention with the perceived effectiveness of the intervention. To do this we calculate the percentage reduction in risk of death due to using prevention: $(p_{wo}-p_w)/p_{wo}$, with p_{wo} and p_w the probabilities of death without and with the preventive intervention, respectively. Again individuals' subjective probabilities are not in line with the actual risk reduction. Here there is more variation, partially due to the fact that some people report higher probabilities of death with preventive care than without it. While this may seem irrational, it would not be surprising if some individuals actually feel this way. One possible explanation might be significant media attention to the sudden death of several people in Israel immediately after receiving a flu shot in 2006, which led to a postponement of the vaccination program in the Netherlands. In addition, many people do not trust vaccinations and fear that the live virus in the vaccination will cause them to get influenza.

A particularly useful tool to measure the accuracy of risk perceptions is the probability weighting function described in Prelec (1998):

$$(1)\quad w(p) = \exp[-\ln(-\ln p)^{\alpha}]$$

Here $w(p)$ is the perceived probability and p is the actual probability. The parameter α is a summary measure of the degree of bias. If α=1 there is no bias, if α=0 the function is similar to a step function with all underlying probabilities being reported at the same value. Given that we have multiple observations of perceived and epidemiological probabilities for each individual in our sample), we can estimate individual specific values of α.[8] We estimate the α's as the coefficient on $\ln[-\ln(p)]$ in individual specific regressions (without a constant) explaining $\ln[-\ln(w(p))]$. Figure 1 shows the shape of the probability weighting function for various values of α's, including the median of our estimates (α=0.50), the 25th percentile

[8] Our estimates are based on the risk of dying from influenza, with and without a flu shot, the risk of getting breast cancer, the risk of dying of breast cancer, with and without mammograms over 10 and 20 years, the risk of developing heart disease, and the risk of dying of heart disease, with and without aspirin over `10 and 20 years.

(α=0.21), and the 75th percentile, (α=0.75. Lower values of α indicate the small probabilities are overweighted more, higher values of α indicate the small probabilities are overweighted less.

Table 5 reports a regression that describes the relationship between these estimated values of α and a number of observed respondent characteristics. Higher values of α, less over-estimation of small probabilities, are associated with higher income, numeracy, college education, and with being male. Being in excellent or good health is also associated with higher values of α. This may occur for 3 reasons. First, poor health may be associated with higher actual risk than predicted by the epidemiological models. Thus, individuals' assessments of their own risk may accurately be higher than the epidemiological prediction, leading to lower alphas for those in poor health. Second, individuals in poor health may have more need for accurate information, leading to higher alphas for those in poor health. Third, good health may be a proxy for numeracy and literacy, leading to higher alphas for those in good health. Receiving an invitation for a flu shot, leads to lower levels of α, and thus more overestimation of risks. This may occur because the invitations alert people to the importance of receiving a flu shot and make the risks more salient.

6.2 The Take-Up of Flu Shots and Mammograms

The first two columns of Table 6A reports regressions explaining flu shot take up in the fall of 2007 and after September 2008. Despite the fact that individuals overestimate their risk of disease, there is a highly significant relationship between subjective probabilities and take-up. It is important to note that in column 2, the information on the explanatory variables, notably the various perceived probabilities, come from the September 2008 survey, while the dependent variable, flu shot take-up, comes from the January 2009 survey. This makes it implausible that the results are driven by a justifications bias. While justification bias could play a role in the relationship between *past* flu shot take-up and current perceived probabilities (e.g. reporting low probabilities to justify not taking-up a flu shot previously), it is highly in likely to play a role in this case (e.g. taking-up a flu shot in October 2008 to justify the high probabilities answered in September 2008).

Th effects of perceived probabilities are large and significant. For example, the coefficient on our measure of perceived effectiveness , $(p_{wo}-p_w)/p_{wo}$, implies that if the flu shot would change the probability of getting the flu from 1 to 0, take-up would increase by 16 percentage points. Individuals who perceive that flu shots increase the chance of influenza are 3 percentage points less likely to receive a flu shot. An very large effect is found for the invitation to receive the flu shot, which increases take by 32 percentage points. In addition to the effect of receiving the invitation (which partly depends on age), we find a strong separate positive age effect. Additional effects are also found for people with diabetes and heart disease, risk factors that increase the risk of influenza and severe complications. We find that having a college degree lowers the probability of flu shot take-up. One explanation is that the higher educated have higher opportunity costs of time. Alternatively, they may be in better which lower the rationale for taking a flu shot.

Column 3 of Table 6A, considers the use of aspirin for the prevention of heart disease. The of perceived risks and effectiveness are smaller than those found with influenza. If aspirin would change the probability of dying of heart disease from 1 to 0, take-up would increase by 6 percentage points. Men are more likely to use aspirin, as are those with high cholesterol. Other coefficients are insignificant.

Table 6B considers preventive interventions offered only to subsets of the population. The first to columns consider mammograms and pap smears. The third column considers tests for sexually transmitted diseases. In all three cases, the effectiveness of the intervention in reducing the risk of death increases the takeup of the intervention. If mammograms are perceived to change the probability of dying of breast cancer from 1 to 0, take-up would increase by 3 percentage points. For pap smears and STD tests the effect is 10 percentage points. The effect of invitations on mammogram and pap smear take up is very large, increasing takeup by 75 and 71 percentage points respectively. Numeracy and family history of breast cancer increase the take up of mammograms. For tests for STDs men are 11 percentage points less likely to have undergone a test and those with a college degree are 11 percentage points more likely to have undergone a test.

Table 7, considers the effect of both subjective and epidemiological probabilities on take up of preventive care. Column 1 and 2 consider the use of flu shots; moving from a probability of 0 to a probability of 1 of getting influenza increases take up by 22 or 23 percentage points for 2007 and 2008 respectively. If we consider the risk of death from influenza, the effects are 6 or 7 percentage points respectively. The epidemiological risks are significant in 2007 but not in 2008, due to changes in eligibility for flu shots, as discussed in section 2. For mammograms, after controlling for age and the government invitation, epidemiological probabilities have not effect on take up. Perceived risks do continue to have an effect on take up; moving from a probability of 0 to a probability of 1 of getting breast cancer increases take up by 8 percentage points. For heart disease and the use of aspirin, only the epidemiological probabilities matter, perhaps because they are closely aligned with expert advice. An individual with a high risk of heart disease is more likely to have their doctor recommend the use of aspirin. The perceived risk has no effect on take up of asprin.

All together the results indicate that while people have extremely poor perceptions of absolute probabilities, they seem to be aware of the qualitative relationship between risk factors and risk probabilities.

7. Conclusion

Preventive health care interventions can extend the duration of life, improve the quality of life, and contribute to a more effective health care system. Policies like the flu shot, mammogram, and pap smear programs, however, can be effective and efficient only when individuals understand the health risks involved and act accordingly. We find that while respondents are aware of some of the qualitative relationships between risk factors and probabilities of sickness and death, they generally have very poor perceptions of the absolute probability levels. This is partly due to the fact that this information is often simply not available or very difficult to obtain for non-specialists (and sometimes even for specialists). These preventive health care programs are therefore likely to benefit from better and more easily accessible quantitative information on the medical effectiveness of the intervention itself and the associated risks of sickness and death.

In principle, the preventive health care choices considered here offer an opportunity to measure individual's willingness to pay or risk reductions on the basis of revealed preferences. For example, suppose we observe a person who does not take a flu shot at age 59 (just below the free flu shot eligibility age) and does take a flu shot at age 60 (free flu shot). All else equal, this would allow us to estimate an upper and a lower bound for the person's willingness to pay for this particular risk reduction. Implementing such a procedure, however, is a road covered with pitfalls. First, the all else equal condition requires controlling for a large number of factors (like the amount of information available, spouse's health and behavior, the flu incidence in the population, and the opportunity costs of time). Secondly, the lion's part of the personal costs of getting the flu and are not the risk of death but the disutility from being ill and absent from work. Finally, deviations from rationality like hyperbolic discounting and other time-inconsistent preferences, prohibits a meaningful interpretation of the outcomes of such an exercise.

Our results indicate that written invitations for flu shots and mammograms strongly increased the likelihood of participation. One topic for future research is how information provision can be used more effectively through a careful design of information, both in terms of (quantitative) content and in terms of framing.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.
Male	5687	0.460	0.498
Age	5687	47.281	15.451
Net household income	5686	3034	8289
Education level:	56869		
Basisonderwijs	502	0.808	
Vmbo	1504	0.265	
havo/vwo	628	0.110	
mbo	1344	0.236	
hbo	1282	0.226	
wo	426	0.075	
Received a flu shot in 2007	5687	0.226	0.418
Received a flu shot in 2008	4693	0.287	0.452
Had a mammogram in last 2 years	3072	0.394	0.489
Had a pap smear in last 5 years	3072	0.605	0.489
Have used the kidney check	1404	0.237	0.426
Take daily low dose aspirin	5687	0.056	0.230
Actual Time for flu shot (if received)	1285	19.713	15.095
Expected Time for flu shot (if not received)	4401	34.878	26.820
Actual Cost for flu shot (if received)	1285	0.929	7.651
Expected Cost for flu shot (if not received)	4402	26.472	30.954
Actual Time for Mammogram (if received)	1211	46.459	33.177
Expected Time for Mammogram (if not received)	1860	66.935	45.809
Actual Cost for Mammogram (if received)	1211	2.130	14.312
Expected Cost for Mammogram (if not received)	1861	74.843	131.967
Actual Time for Pap Smear (if received)	1860	35.349	25.019
Expected Time for Pap Smear (if not received)	1212	42.343	33.132
Actual Cost for Pap Smear (if received)	1860	2.229	15.278
Expected Cost for Pap Smear (if not received)	1212	37.644	60.009
Actual Time for STD Test (if received)	331	54.613	69.755
Expected Time for STD Test (if not received)	1071	53.422	46.487
Actual Cost for STD Test (if received)	333	5.979	31.631
Expected Cost for STD Test (if not received)	1071	45.719	55.152

Table 2: Annual Influenza Associated Mortality Rates per 100,000 People by Age

Age	Conservative Measure: Underlying Pneumonia and Influenza Deaths	Moderate Measure: Underlying Respiratory and Circulatory Deaths	Liberal Measure: All-Cause Deaths
5 to 49	0.2	0.5	1.5
50 to 64	1.3	7.5	12.5
65 plus	22.1	98.3	132.5

Note: from Table 5 of Thompson et. al. (2003). Based on death due to influenza from the 1990-1991 through 1998-1999 seasons.

Table 3: Subjective and Epidemiological Probabilities of Getting a Disease (percentages)

Disease	Time Period	Subj/Epid probability	Mean	Standard dev	Min	Median	Max
Influenza	1 year	Subj w/ flu shot	19.59%	21.49%	0	10.11%	100%
		Epid w/flu shot	-	-	-	-	-
		Subj w/o flu shot	30.95%	26.69%	0	20.64%	100%
		Epid w/o flu shot	-	-	-	-	-
		Subj Effectiveness $(p_{wo}-p_w)/p_{wo}$	-303%	14042%	-999900%	33.33%	100%
		Epid					
Breast Cancer	5 year	Subj	19.131%	19.186%	0%	10.145%	100%
		Epid	0.865%	0.740%	0.003%	0.796%	3.642%
	10 year	Subj	21.626%	19.812%	0%	14.465%	100%
		Epid	1.918%	1.490%	0.009%	1.769%	7.137%
Cervical Cancer	5 year	Subj	13.71%	17.28%	0%	6.65%	100%
		Epid	<1%	-	-	-	-
	10 year	Subj	15.20%	17.69%	0%	9.86%	100%
		Epid	<1%	-	-	-	-
Sexually Transmitted Disease	5 year	Subj	7.40%	12.93%	0%	1.83%	99.3%
		Epid		-	-	-	-
	10 year	Subj	8.19%	13.56%	0%	2.44%	98.38%
		Epid		-	-	-	-
Aids	5 year	Subj	3.78%	9.34%	0%	0.93	99.99
		Epid		-	-	-	-
	10 year	Subj	4.03%	9.25%	0%	1	99.76
		Epid		-	-	-	-
Heart Disease	5 year	Subj	16.40%	18.42%	0%	10%	100%
		Epid	6.40%	5.91%	1%	4%	47%
	10 year	Subj	19.52%	19.83%	0%	10.32%	100%
		Epid	12.80%	11.81%	2%	8%	94%

Table 4: Subjective and Epidemiological Probabilities of Dying (percentages)

Table 4A: Subjective and Epidemiological Probabilities of Influenza Related Death

Time Period	Prevention	Subj/Epid probability	Mean	Stan. Dev	Min	Median	Max
1 year	With flu shot	Subj	11.14%	23.35%	0%	1.1500%	100%
		Epid- cons	0.001%	0.003%	0.00005%	0.00005%	0.0089%
		Epid- mod	0.006%	0.014%	0.0001%	0.0001%	0.0398%
		Epid- hi	0.009%	0.018%	0.0003%	0.0003%	0.0536%
	Without flu shot	Subj	13.24%	23.96%	0%	2%	100%
		Epid- cons	0.007%	0.015%	0.0002%	0.0002%	0.0447%
		Epid- mod	0.032%	0.068%	0.0006%	0.0006%	0.1988%
		Epid- hi	0.044%	0.093%	0.0017%	0.0017%	0.2680%
	Effectiveness of flu shot $(p_{wo}-p_w)/p_{wo}$	Subj	-105%	1942%	-75755%	1.393%	100%
		Epid	80%				

Table 4B: Subjective and Epidemiological Probabilities of Death from Breast Cancer

Time Period	Prevention	Subj/Epid probability	Mean	Stan. Dev	Min	Median	Max
10 year	With mammogram	Subj	15.80%	18.06%	0%	10%	100%
		Epid	0.195%	0.149%	0.001%	0.180%	0.792%
	Without mammogram	Subj	26.36%	23.66%	0%	20%	100%
		Epid	0.229%	0.176%	0.001%	0.211%	0.931%
	Effectiveness of mamm $(p_{wo}-p_w)/p_{wo}$	Subj	12.17%	459.%	-16485%	43.24%	100%
		Epid	15%				
20 year	With mammogram	Subj	17.34%	18.21%	0%	10.09%	100%
		Epid	0.279%	0.155%	0.015%	0.267%	0.903%
	Without mammogram	Subj	28.85%	24.56%	0%	20.41%	100%
		Epid	0.328%	0.183%	0.017%	0.314%	1.062%
	Effectiveness of mamm $(p_{wo}-p_w)/p_{wo}$	Subj	16.77%	439%	-19229%	38.71%	100%
		Epid	15%				

Table 4C: Subjective Probabilities of Death from Heart Disease

Time Period	Prevention	Subj/Epid probability	Mean	Stan. Dev	Min	Median	Max
10 year	With aspirin	Subj	16.61%	19.00%	0%	10%	100%
		Epid	0.493%	0.468%	0.068%	0.408%	3.196%
	Without aspirin	Subj	19.68%	21.52%	0%	10.09%	100%
		Epid	0.725%	0.688%	0.1%	0.6%	4.7%
	Effectiveness of aspirin $(p_{wo}-p_w)/p_{wo}$	Subj	-6%	341%	-13700%	1%%	100%
		Epid					
20 year	With aspirin	Subj	20.08%	21.14%	0%	10.32%	100%
		Epid	4.930%	4.679%	0.68%	4.08%	31.96%
	Without aspirin	Subj	23.78%	23.75%	0%	15%	100%
		Epid	7.250%	6.881%	1%	6%	47%
	Effectiveness of aspirin $(p_{wo}-p_w)/p_{wo}$	Subj	-18%	1388%	-99900%	2%	100%
		Epid					

Table 5: OLS Regressions Predicting Alpha (overweighting of small probabilities) As Described by Prelec (1998)

	Whole Sample	Only those with Alpha between Zero and One	Women	Women with Alpha between Zero and One
Dummy if Male	0.036*	0.073***	0.000	0.000
	(0.019)	(0.008)	(0.000)	(0.000)
ln(net household income)	0.002	0.017**	-0.003	0.013
	(0.018)	(0.008)	(0.018)	(0.009)
Numeracy	0.211***	0.045**	0.200***	0.056**
	(0.044)	(0.019)	(0.047)	(0.024)
Did not finish 2ndary education	0.010	0.005	0.074*	0.018
	(0.036)	(0.015)	(0.039)	(0.020)
MBO (similar to Associates degree)	0.003	-0.020*	0.001	-0.019
	(0.026)	(0.011)	(0.029)	(0.014)
HBO or WO (Bachelors degree or higher)	0.042*	0.010	0.044	0.017
	(0.025)	(0.010)	(0.028)	(0.014)
Self Assessed Health is Excellent or Good	0.101***	0.060***	0.106***	0.057***
	(0.022)	(0.009)	(0.025)	(0.012)
Flu Shot Invitation	-0.068***	-0.029***	-0.008	-0.010
	(0.023)	(0.010)	(0.025)	(0.012)
Mammogram initiation			-0.030	-0.023
			(0.038)	(0.019)
Pap Smear initiation			-0.072**	-0.002
			(0.031)	(0.015)
Constant	0.410***	0.388***	0.402***	0.382***
	(0.141)	(0.060)	(0.147)	(0.075)
Observations	4928	3743	2650	2109
R-squared	0.044	0.093	0.044	0.066

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regressions also control for 5 year age groups, and dummies for visual scales.

Table 6A: OLS Regressions Predicting Use of Preventive Care: Whole Sample

Dependent Variable	Flu Shot in 2007 (before survey)	Flu Shot in 2008 (after survey)	Use Aspirin for Prevention of Heart Disease
Subjective effectiveness at preventing disease: (pwo-pw)/pwo, if effectiveness is positive	0.0018*** (0.0001)	0.0016*** (0.0002)	
Dummy if subjective effectiveness of preventing disease is negative	-0.0083 (0.0111)	-0.0324** (0.0143)	
Subjective probability of Getting Disease without intervention	0.0015*** (0.0001)	0.0016*** (0.0002)	
Subjective probability of Getting Disease			-0.0006*** (0.0002)
Subjective effectiveness at preventing death: (pwo-pw)/pwo, if effectiveness is positive	-0.0000** (0.0000)	-0.0000** (0.0000)	0.0006*** (0.0001)
Dummy if subjective effectives of preventing death is negative	-0.0477*** (0.0093)	-0.0393*** (0.0120)	0.0026 (0.0048)
Subjective probability of Dying (in 10 year for all but flu shot) without intervention	0.0007*** (0.0002)	0.0008*** (0.0002)	0.0008*** (0.0002)
Received invitation for intervention	0.4405*** (0.0095)	0.3216*** (0.0124)	
Expected or Actual monetary cost of intervention	-0.0014*** (0.0001)	-0.0010*** (0.0002)	
Expected or Actual time cost of intervention	-0.0008*** (0.0002)	-0.0009*** (0.0002)	
Dummy if Male	0.0093 (0.0074)	-0.0004 (0.0096)	0.0142*** (0.0037)
ln(net household income)	0.0050 (0.0067)	-0.0060 (0.0087)	-0.0006 (0.0033)
Numeracy	-0.0359** (0.0170)	-0.0152 (0.0221)	-0.0030 (0.0083)
Did not finish 2ndary education	-0.0008 (0.0136)	0.0118 (0.0174)	-0.0039 (0.0070)
MBO (similar to Associates degree)	-0.0162* (0.0098)	-0.0203 (0.0128)	-0.0002 (0.0049)
HBO or WO (Bachelors degree or higher)	-0.0340***	-0.0144	0.0033

	(0.0094)	(0.0122)	(0.0047)
Dummy if has Diabetes	0.1108***	0.1118***	0.0034
	(0.0144)	(0.0183)	(0.0079)
Dummy if has Heart Disease	0.0911***	0.0572***	
	(0.0130)	(0.0162)	
Dummy if has High Cholesterol			0.0191***
			(0.0057)
Self Assessed Health is Excellent or Good	-0.0274***	-0.0368***	0.0016
	(0.0085)	(0.0110)	(0.0041)
Dummy if friends have died of disease	0.0664***	0.0578*	0.0024
	(0.0246)	(0.0314)	(0.0037)
Constant	-0.0443	0.0314	-0.0129
	(0.0546)	(0.0708)	(0.0264)
Observations	4872	4265	4454
R-squared	0.654	0.565	0.060

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regressions also control for 5 year age groups.

Table 6B: OLS Regressions Predicting Use of Preventive Care: Sample to Relevant Demographic Groups

Dependent Variable	Mammogram in last 2 years	Pap Smear in Last 5 Year	Test for Sexually Transmitted Disease in Past
Sample	Women	Women	Younger than 40
Subjective probability of Getting Disease	0.0006	0.0008	0.0012
	(0.0004)	(0.0006)	(0.0010)
Subjective effectiveness at preventing death: (pwo-pw)/pwo, if effectiveness is positive	0.0003*	0.0010***	0.0010**
	(0.0002)	(0.0002)	(0.0004)
Dummy if subjective effectives of preventing death is negative	0.0169	-0.0058	0.0031
	(0.0172)	(0.0195)	(0.0334)
Subjective probability of Dying (in 10 year for all but flu shot) without intervention	0.0003	0.0005	-0.0001
	(0.0003)	(0.0005)	(0.0008)
Received invitation for intervention	0.7505***	0.7100***	0.4718***
	(0.0188)	(0.0174)	(0.0939)
Expected or Actual monetary cost of intervention	-0.0004***	-0.0017***	-0.0026***
	(0.0001)	(0.0001)	(0.0002)
Expected or Actual time cost of intervention	-0.0001	0.0002	0.0008***
	(0.0001)	(0.0002)	(0.0002)
Dummy if Male			-0.1118***
			(0.0240)
ln(net household income)	0.0091	0.0133	-0.0193
	(0.0088)	(0.0100)	(0.0193)
Numeracy	0.0711***	0.0258	-0.0590
	(0.0229)	(0.0259)	(0.0571)
Did not finish 2ndary education	0.0087	0.0038	-0.0203
	(0.0188)	(0.0214)	(0.0530)
MBO (similar to Associates degree)	0.0126	0.0056	0.0087
	(0.0136)	(0.0156)	(0.0307)
HBO or WO (Bachelors degree or higher)	0.0189	-0.0162	0.1149***
	(0.0132)	(0.0151)	(0.0320)
Dummy if has Diabetes	-0.0362*	-0.0464*	-0.0341
	(0.0215)	(0.0242)	(0.0859)
Dummy if has Heart Disease	0.0060	-0.0057	0.1463*

	(0.0199)	(0.0229)	(0.0841)
Self Assessed Health Excellent or Good	0.0062	0.0084	
	(0.0119)	(0.0136)	
Dummy if has High Cholesterol			-0.0088
			(0.0243)
Dummy if Family Member had disease	0.0351**	-0.0358	
	(0.0165)	(0.0325)	
Dummy if friends have died of disease	0.0098	0.0135	0.0063
	(0.0107)	(0.0199)	(0.0931)
Constant	-0.1282*	-0.0494	0.3954**
	(0.0718)	(0.0812)	(0.1589)
Observations	2567	2578	1176
R-squared	0.742	0.662	0.194

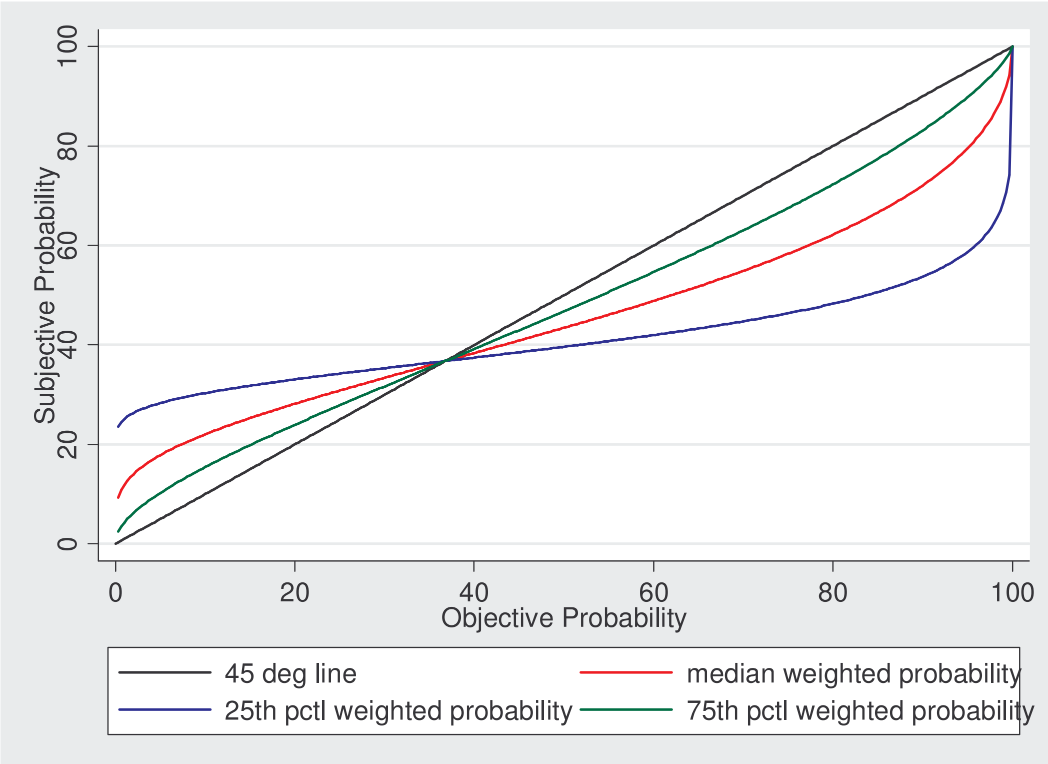
Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regressions also control for 5 year age groups.

Table 7: OLS Regressions Predicting Use of Preventive Care: Comparing the Role of Subjective and Objective Probabilities

Dependent Variable	Flu Shot in 2007 (before survey)	Flu Shot in 2008 (after survey)	Mammogram	Use Aspirin for Prevention of Heart Disease
Sample	Whole Sample	Whole Sample	Women	Whole Sample
Subjective Probability of Flu without flu shot	0.0022*** (0.0001)	0.0023*** (0.0002)		
Epidemiological Probability of Flu without flu shot	0.4859*** (0.1004)	-0.1751 (0.1284)		
Subjective Probability of Death from Flu without flu shot	0.0007*** (0.0002)	0.0006*** (0.0002)		
Subjective Probability of Disease in 10 years			0.0008*** (0.0003)	0.0000 (0.0001)
Epidemiological Probability of Disease in 10 years			-0.0098 (0.0114)	0.0021*** (0.0003)

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regressions also control for 5 year age groups (age and age squared for flu shots), invitations, expected or actual costs, male, household income, numeracy, education dummies, and health indicators.

Figure 1: The Relationship Between Subjective Risk and Epidemiological Risk



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