Examining the relationship between education and health

The link with time discounting

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ABSTRACT: This study aims to make an innovative contribution to the existing literature on the relationship between education and health. The possible underlying mechanism of this relationship, time discounting, is examined. Using the 'Households in the Netherlands 1995' survey it is investigated if time discounting can partly account for the relationship between education and health. It was found that no association exists between time discounting and health and time discounting and education. However, education and health, as the literature suggests, are significantly associated. Partial correlations including the controlling variables age and gender showed a few minor changes in the association between education and health. A model including time discounting did not show any significant changes in the association.

KEYWORDS: health, education, time discounting, association.

1. Introduction

Differences in unhealthy behaviors across social groups have received much attention in recent years due to its alarming situation in several industrial countries (Cutler & Glaeser, 2005). In the United States, smoking rates of the higher educated are one-third the rate for the less educated. Obesity rates are half as high among the better educated, as is heavy drinking. Nearly half of all deaths in the United States are attributable to behavioral factors, most importantly smoking, excessive weight, and heavy alcohol intake (Cutler & Lleras-Muney, 2010). On the other hand, the life expectancy in industrial countries is also still increasing (Knoops & Van den Brakel, 2010).

Moreover, it is clear that health varies between countries and even within countries or areas. A major reason for these differences in health outcomes is differences in health behavior across social groups. All countries, including those ranking high on indices of economic prosperity and human development, have systematic inequalities in mortality and morbidity between citizens with a higher and a lower socioeconomic position, as indicated by education, occupation, income or wealth (Mackenbach, 2012). These health inequalities are often substantial, and usually amount to between five and ten years difference in average life expectancy at birth (Mackenbach, 2012).

Many countries are now systematically monitoring these health inequalities. However, the mechanism through which education and health influence each other has been largely unexplained and heavily debated (Van der Pol, 2010). Also, few studies have focused on a potential mechanism that can account for a part or even the entire relationship between education and health. There are several potentially important factors discussed in the literature that influence health behavior, such as the environment or hereditary factors. Unobserved factors such as family background, genetic traits or other individual differences, for example the ability to delay gratification, could also explain why the more educated are healthier (Cutler & Lleras-Muney, 2006). This paper looks at the relationship between health and education in greater depth.

Cutler and Lleras-Muney (2006) state that there are three possible reasons for the link between health and education. One possibility is that increasing education improves health. A second possibility is that poor health leads to low levels of schooling. And lastly, there may be third factors that influence both schooling and health (Cutler & Lleras-Muney, 2006). An example of a third factor is discounting of future health gains or losses. So, a possibility is that individuals with lower time discounting are more likely to invest more heavily in both education and health (Fuchs, 1982). It could even be the case that a great part of the association between education and health can be attributed to time discounting.

The term time discounting is used broadly to encompass any reason for caring less about a future consequence (Frederick et al., 2002). This includes factors that diminish the expected utility generated by a future consequence, e.g. the probability of premature death or changing tastes. The term time preference is used to refer, strictly, to the preference for immediate utility over delayed utility (Frederick et al., 2002).

The concept of time preference, or the rate that an individual is willing to exchange present for future consumption is in most cases positive. In this paper time discounting is distinguished from time preference. Time discounting is used in this study because in this case an individuals' time preference is connected to an individuals' health behavior. Here, time discounting is a function of real time preferences, and the uncertainty of survival. The discount parameter depends on time preference and on the survival function. For example, in industrial countries, excessive food intake leads to immediate pleasure or reduction of distress, while it reduces future health outcomes and physical appearance (Borghans & Golsteyn, 2006).

The paper is organized as follows, in the theoretical framework the important relationships between education, health and time discounting are discussed. A number of theories will be examined and the research question is posed. Moreover, the data and methods are described. Furthermore, the results are discussed and a conclusion has been formulated.

2. Theoretical framework

In this chapter the important relationships between variables will be discussed in order to formulate the main question and find theoretical answers to this question. As mentioned, there are several important factors, unobservable as well as observable, that influence health in a certain way. Given the similarity across so many different behaviors, Cutler and Lleras-Muney (2010) focused on broad explanations for different health behaviors, rather than explanations specific to any particular behavior. They have found several satisfying mechanisms that account for the education differences in a variety of health behavior or the other way around. However, current explanations of socioeconomic inequalities in both smoking and obesity, including socioeconomic variations in knowledge and environmental barriers and contextual factors, leave substantial variation unexplained (Adams & White, 2008).

2.1 Potential explanation; time discounting

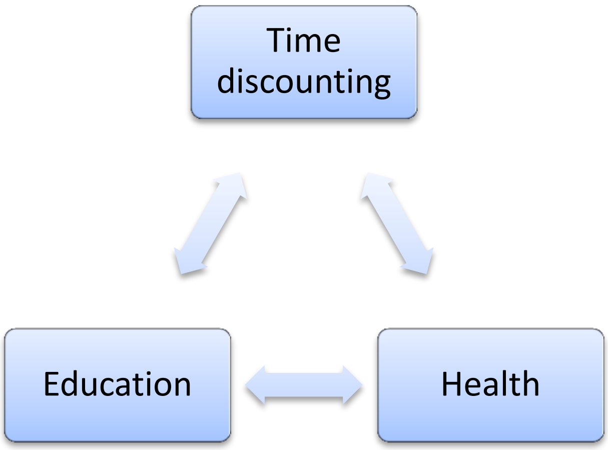
A useful starting point is the Grossman (1972) model in which investment in human capital, in particular health, is highlighted. Health behaviors will obviously differ across people, but for a given person, behaviors will be highly correlated: those who value their health highly and care enough about the future will invest more in healthy behaviors than those who do not (Cutler & Glaeser, 2005). As such, variations in health behavior will be explained by differences in time discounting and the value of the future. Health is viewed as both a consumption good and an investment good. Education will lead to better health because education improves health production efficiency. Intertemporal choices, decisions involving tradeoffs among costs and benefits between immediate or delayed outcomes, are important and ubiquitous. The classic example of discounting involves a choice between a larger and a smaller reward, where the smaller reward is available sooner than the larger one (Green & Myerson, 2004).

Furthermore, the uncertainty about the length of life plays a key role in determining the trade-off between present and future consumption or rewards. Individuals' time preferences, will therefore influence how individuals make these intertemporal choices such as whether or not to invest in education and whether to engage in health affecting behavior, such as smoking, drinking and drug use (Van der Pol, 2010). Therefore, time discounting affects the relationship between education and health as an individuals' discount rate affects investments in both health and education.

Investments represent a trade-off between current costs and future benefits. Health investments as giving up smoking involve a trade-off between costs now, such as withdrawal symptoms, and future benefits, such as increased life expectancy. Investments in education also involve current costs, for example college fees and many time, and future benefits, such as increased earnings. On the basis of the human capital theory as used by Grossman (1972), which indicates healthy behavior as an investment, variations in health outcomes are often explained by differences in individual discount rates. Better educated people will have lower discount rates or risk aversion than less educated. High time discounting assumes that an individual prefers to delay undesirable outcomes whenever possible. However, individuals may exhibit high time discounting in some instances because of the anticipation of future unpleasant consequences. People might prefer to experience a temporary illness, rather now, in order to eliminate dread. The higher the discount rate, the lower the discount factor and the less importance one assigns today to utility in a future period. Because of this, when the discount rate rises, the importance assigned to utility in the future period falls, and one is more likely to accept long run decreases in health and appearance in exchange for the immediate gratification of unhealthy behaviors (Van der Pol, 2010).

Exponential discounting assumes that when an individual waits for a reward, the risk that something will occur at any given moment to prevent the reward's consumption remains constant. Several articles have measured whether differences in, for example, BMI between people at a certain moment of time are related to time discounting, and have found a positive effect of time discounting (Borghans & Golsteyn, 2006; Smith et al., 2005; Zhang & Rashad, 2008). Many health-promoting messages appeal to a desire to make the future better, or at least healthier, by encouraging one to adopt healthy behaviors now in order to safeguard one's health in the future (Adams & White, 2008). Figure 1 shows the different associations the literature has been looking into in the past decades. All associations will be discussed in the next section of this paper.

Figure 1: Different associations



2.2 Association 1: Education and health

Through education, individuals have better knowledge about the relationship between certain health behaviors and health outcomes. Schooling raises a person's knowledge about the production relationship and therefore increases an individuals' ability to select a healthy diet, avoid unhealthy habits and make efficient use of medical care (Grossman, 1976). This relates to the example of smoking: the better educated are more successful at quitting smoking than the lower educated, not because they try to quit more frequently or use different methods, but because they are more successful when they do try to quit. Everyone 'knows' that you should not overeat and seat belts are useful, but the better educated may understand it better and know how to process information. Evidence of Cutler and Lleras-Muney (2010) suggests that education differences in health behaviors are large; better educated people are less likely to smoke, less likely to be obese, less likely to be heavy drinkers, more likely to drive safely and live in a safe house, and more likely to use preventive care. A good example of the health differences by education is this: "In 1990, a 25 year-old male college graduate could expect to live another 54 years. A high school dropout of the same age could expect to live 8 years fewer" (Cutler & Lleras-Muney, 2010). Cutler and Lleras-Muney (2010) and several other authors state that resources are a really important factor. They have found that income, health insurance, and other economic indicators account for a great part of the education differences in health behaviors. Also, the authors estimated that access to material resources, such as gyms and smoking cessation methods are of great importance.

The relationship between education and health also works the other way around. A causal relationship from health to education can result from experiences during childhood. Children in poor health usually obtain less schooling and they are also more likely to be unhealthy adults. For example, children that are born with low or very low birth weight, which is an important health marker for the rest of your life, obtain less schooling than those born with higher weights. This means that older children who are sick or malnourished during childhood are more likely to miss school, less likely to learn while in school, and ultimately experience fewer years of schooling. The direction and strength of the association depends on the type of disease and whether one is looking at incidence or survival. In conclusion, this relationship works both ways; being healthy, or having the resources to be and stay healthy, provides you with more resources or opportunities to get (more) education.

2.3 Association 2: Education and time discounting

Schooling affects time discounting because those with more schooling are more willing to invest with a lower rate of return. In addition, through repeated practice at problem-solving in school or during studies people learn the art of scenario simulation. Thus, better educated people are more productive at reducing the distance of future pleasures (Becker & Mulligan, 1997).

In their article, Becker and Mulligan (1997) state that people are not equally patient. Using the Panel Study of Income Dynamics, they hypothesize that the rich are more ‘patient’ than the poor, because wealth causes patience (Lawrance, 1991; Becker & Mulligan, 1997) and the other way around; patience causes wealth. More patience or self-control may be the reason why some people choose to continue their schooling in order to obtain a higher socioeconomic status in the future. Those people do not (heavily) discount the future. Only people who have a low discount rate, acknowledge the fact that there are Current costs and future benefits and will thus invest in education. Eventually, they will experience more years of education. Which leads to the following hypothesis:

H1: An individuals’ level of education is negatively associated with time discounting.

2.4 Association 3: Health and time discounting

Many health-related behavior such as quitting smoking, consuming a healthy diet, and taking adequate exercise involve a trade-off between immediate pleasure and potential future health benefits. Variations in time discounting help to explain variations in cigarette smoking, diet, exercise, and the like amongst individuals. This is due to the fact that the value an individual attributes to future health gains now, will affect an individuals’ decision making, for example whether to stop smoking or overeat or not. This is a situation which creates a trade-off between health gains in the future versus losses in the present, for example loss of pleasure.

Differences in health cause differences in time discounting because greater health reduces mortality and raises future utility levels. Healthy people are expected to live longer and will be able to enjoy utility well into the future. Those with poor health are not expected to live as long. This makes the sacrifice of current utility in favor of the future utility less attractive for them. In life-cycle models of choices with certainty, consumers who do not want to leave inheritance only consider utilities over their own lifetimes (Becker & Mulligan, 1997). This leads to the second hypothesis:

H2: An individuals' time discounting is negatively associated with different health behaviors/outcomes.

Although there is many literature on the work of mechanisms underlying the link between health and education, it has not been conclusive. Because there is theoretical and empirical evidence that time perspective is related to both education and health-related lifestyle variables, it is highly plausible that time discounting influences the relationship between education and these health variables or even attributes for a great part of the relationship. Given variation in time discounting, it would not be surprising to observe that individuals with low rates of time discounting would invest in many years of schooling and in health enhancing activities. According to this view, schooling has no direct effect on health, but the observed correlation is due to both schooling and health as being dependent on time preference (Fuchs, 1980).
This leads to the final hypothesis:

H3: Time discounting (partially) accounts for the relationship between education and health, so the association between education and health will decline if time discounting is controlled for.

Satisfying arguments for all possible relationships are discussed here. More years of education raises a person's knowledge about healthy behaviors. Furthermore, individuals in good health are better able to experience more years of education. Schooling also affects an individuals' discount rate, because in school you learn the remoteness of future pleasures. The other way around, having a low rate of time discounting means that you are more willing to invest in more years of education. This is similar for investing in healthy behaviors. Finally, differences in health cause differences in time discounting because greater health reduces mortality and raises future utility levels. In both types of correlation, there is no evidence or proof that changes in one variable cause changes in the other variable. The correlation simply indicates that there is a relationship between the two variables. However, a direction in this relationship is expected.

Still, it will be a challenge to distinguish whether time discounting is either spurious, mediating or maybe even both. Rather than time discounting being exogenous in the relationship between education and health (figure 2), another model is possible, namely that education lowers time discounting, which results in better health because of investments in health (figure 3). The analyses of those models will finally help answer the main question of this paper. The main question of this paper is; *'To what extent will time discounting be accountable for the relationship between education and health?'*

Figure 2: Spurious relationship

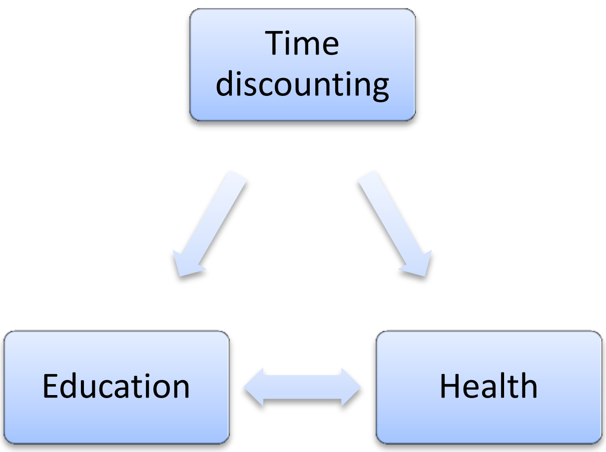


Figure 3: Mediating relationship

3. Data and methods

3.1 Dataset

This paper will analyze the relationship between education and health using the dataset HIN95. In order to explain this relationship, the underlying mechanism, time discounting, has been examined. The second dataset, HIN95Exp, is used to analyze this variable. The 'Households in the Netherlands 1995' survey (HIN95) was initiated in the fall of 1994 by the Utrecht Household seminar. The survey is based on a household sample from the Dutch population. The sample consists of two types of households, couples and single respondents. Couples include both married and cohabiting partners and can be homosexual couples as well. Single respondents are defined as independent or dependent adults and with or without children. The respondents are men and women between 18 and 65 years old. The survey is based on a combination of self-administrated questionnaires and personal interviews. HIN95Exp is a set of experiments which were conducted in connection with the HIN95 household survey. HIN95Exp includes measures for individual traits commonly used in experimental studies, including time discounting, and social preferences. The research team has connected the experiments with the HIN95 household survey. They wanted to learn more about how 'normal' people from Dutch households make decisions in cooperation problems in comparison to the laboratory rats of the social sciences: freshman students (Bruins & Weesie, 1996).

In total, 1821 households were interviewed, 1533 couples and 288 single-person households. Thus, 3354 individuals were interviewed, in total. So, 3354 individuals received one of 32 versions of a booklet with experiments, one of which is used in this study. Eventually, the number of returned booklets summed up to 2321. This is a response rate of 68%.

3.2 Previous methods

In their research, Frederick et al (2002) discuss the different ways to measure time discounting. Over the past three decades, there have been many attempts to measure this rate. Some of these estimates are derived from observations of 'real world' behaviors. For instance, one can interpret which washing machine people buy, a cheap one with high power consumption or an expensive one with low power consumption, as a measure of how much people value the future. Others are derived from experimental elicitation procedures. While there is no real theoretical basis for preferring one of these methods over any other, the small amount of empirical evidence comparing different methods suggests that they yield very different discount rates. Frederick et al. (2002) found that those varied depending on amount, time and hypothetical or real reward. However, there is still insufficient evidence to what extent these different measures correlate.

Many articles use different proxies to measure an individuals' time discount rate, because it is not possible to measure time discounting with one simple question. For example, Borghans and Golsteyn (2006) used a few proxies for time discounting. They selected 25 questions which are clearly related to the concept of an individual discount rate. For example, questions about the management of income, because the idea is that respondents with higher discount rates are more tempted to spend money immediately and will have more problems managing their money. Other questions concerned statements about saving behavior. They have also included seven questions more related to risk aversion than to time discounting, and statements about the attitude referring to the trade-off between the present and the future. Cutler and Lleras-Muney (2010) examined several explanations for the relationship between education and health in the United States and the United Kingdom. Individuals were asked whether they agreed with the following statement: "I live one day at a time and do not really think about the future." However, they warn for errors in the proxies they used, because some were better measures than others. But they did not find these mattered. Obviously, in most cases proxies tend to have limited explanatory power.

Van der Pol (2010) states that a more promising approach, which is becoming increasingly popular, is to use stated preference methods to elicit individuals' time discounting. This is much richer and more robust data (Van der Pol, 2010). This method is used in the booklets to create HIN95Exp. There are several experiments in which the researchers can control for factors that may influence an individuals' implied time discount rate. But, also because the experiments are from 1996, there are some cons. The standard approach assumes that, for instance, Fl. 100,- now and Fl. 100,- in five years generate the same level of utility at the times they are received. However, inflation provides a reason to devalue future monetary outcomes, because through, Fl. 100,- worth of consumption now is more valuable than Fl. 100,- worth of consumption in five years. This confound creates an upward bias in measuring time discounting, and this bias will be more or less pronounced depending on subjects' experiences with and expectations about inflation. Another disadvantage of this method, compared to the 'real world' measure, is the ecological validity. In field studies there is no concern about whether estimated discount rates would apply to real behavior because they are estimated from such behavior (Frederick et al., 2002).

3.3 Variables of interest

3.3.1 Time discounting

Time discounting was used as controlling variable for the link between health and education. In the dataset time discounting is measured as an average of six items that are variations of the same question in the following experiment: *Imagine you have just won Fl. 1.000,- in the state lottery. For the payment you can choose between two alternatives. If you want, the Fl. 1.000,- will be paid to you immediately. But you can also choose to wait three months. The amount you will get after three months will be larger than Fl. 1.000,-. How high does the second amount have to be, so that you prefer waiting three months to getting Fl. 1.000,- immediately?* There were six cases in which an individual had to fill in what he or she would do in this situation.

The question is always how high the second amount has to be, so that you prefer waiting to getting the fixed amount immediately.

1. *Fl. 1.000,- now, at least Fl. [stly1] to wait three months.*
2. *Fl. 500,- now, at least Fl. [stly2] to wait one year.*
3. *Fl. 25,- now, at least Fl. [stly3] to wait one month.*
4. *Fl. 100,- now, at least Fl. [stly4] to wait three months.*
5. *Fl. 10,- now, at least Fl. [stly5] to wait half a year.*
6. *Fl. 10.000,- now, at least Fl. [stly6] to wait two years.*

A common assumption is that people discount delay exponentially with the discount parameter ϴ, where $0 < ϴ < 1$. According to the exponential function, when the smaller sooner and larger later rewards are discounted according to the same value, preference between the two rewards remains constant over time. In contrast, according to the hyperbolic function, when the smaller sooner and larger later rewards are discounted according to the same value, preference between them will reverse as a function of time (Vuchinich & Simpson, 1998). Hyperbolic discounting is proven to be empirically better compared to exponential discounting, but in this research it is assumed that individuals discount exponentially. The exponential and hyperbolic discount rates are highly correlated (Weesie, 2015, personal communication).

This is a fairly good experiment which measures an individuals' patience and thus if someone values or discounts the future. An individuals' discount rate can be elicited for different delays and different outcomes. The time discount parameter is estimated as the average of the six items. Using the average of the six questions will give a standardized value of an individuals' discount rate. Given the fact that the experiment was an open question and there were no answer categories there was room for response error. Every question had a few answers under the given value x_1, even a few zero's. There were two possible interpretations that yield solutions to solve this problem. First, the respondents who answered 0 to the question, and hence will be identified as missing values. Second, we can treat the $x_2 < x_1$ really as the difference between x_1 and x_2. To keep as many respondents as possible in the analysis the second solution was chosen and x_1 was added to their answers.

First, in this paper the utility function is used:

$$U(x,t) = x\Theta^{\wedge}t$$

Where:
U = the utility function.
x = the amount of money
Ө = theta, the measure of time discounting and $0 < \Theta < 1$.
t = time

A low value of Ө means an individual scored high on time discounting which means that an individual prefers to delay undesirable outcomes whenever possible.
The revealed preference method assumes that people's response x_2 satisfies;

$$U(x_1,t_1) = U(x_2,t_2)$$

Where $t_2 > t_1,\ x_2 > x_1$

The four variables in the equation are two different amounts of money, where one is stated in the question, x_1, and the second one, x_2, is the amount the respondent would require for waiting t_2 months. The second t in the equation stands for the moment of the survey and is always 0. Solving for theta leads to the following:

$$\Theta = (x_1/x_2)^\wedge(1/(t_2-t_1)).$$

Looking at question 4, Fl. 100 (x_1) now or at least x_2 in three months (t_2), and assuming that an individual answers 130 (x_2) to the question, the equation is as follows:

$$\Theta = (100/130)^\wedge(1/(3-0)) = .92$$

Or, for example with x_2 is 160:

$$\Theta = (100/160)^\wedge(1/(3-0)) = .85$$

In this case, the respondent has a value of theta (based on one question) of .92. Normally, the difference between x_1 and x_2 is calculated using the current interest rate. So, when you get Fl. 100 or wait three months for the delayed amount, an individual wants to receive 100*interest rate as a compensation for waiting for the money for a whole year. This means, that an individual who answered 130 to question four, expects to receive an interest of 30% over three months as compensation for waiting for the reward. This indicates an interest of (1.3^4-1)*100 = 185% for a year.

Table 1. Descriptive statistics for the 6 measures of time discounting

	N	Minimum	Maximum	Mean	Std. Deviation
TD 1	2178	.69	1	.96	.03
TD 2	2117	.83	1	.97	.02
TD 3	2046	.02	1	.73	.21
TD 4	2075	.44	1	.90	.09
TD 5	2036	.45	1	.86	.11
TD 6	2131	.94	1	.99	.01

Table 2. Correlation coefficients time discounting.

	TD1	TD2	TD3	TD4	TD5	TD6
TD 1	1	.63**	.43**	.53**	.44**	.51**
TD 2	.63**	1	.54**	.65**	.59**	.55**
TD 3	.43**	.54**	1	.73**	.70**	.33**
TD 4	.53**	.65**	.73**	1	.72**	.44**
TD 5	.44**	.59**	.70**	.72**	1	.37**
TD 6	.51**	.55**	.33**	.44**	.37**	1

Note: N varies between 2014 and 2178. **. Correlation is significant at the 0.01 level (2-tailed),

Table 3 shows the correlation coefficients between all measures of theta. In all cases $p<.001$. The correlation is towards a perfect positive association ($r^2=1$). This means that all measures of theta are used to calculate an individuals' discount rate. Ideally, the six items of time discounting should be equal or almost equal, because it is attempted to measure the same through different variations of the same question.

3.3.2 Education

Educational attainment is generally measured in educational credentials obtained (Van der Pol, 2011). Some researchers convert this to years of formal schooling. The household survey collects information on both the education attended and completed. The highest completed education is available in the 'Households in the Netherlands 1995' survey. Only the highest education completed is used in this paper.

3.3.3 Health

As mentioned earlier, health is a broad concept. In this research, health is measured by a couple of variables from the dataset. It is decided not to combine the six measures of health because the variables differ in aspects of health.

First, each respondents' BMI is calculated by dividing the individuals' weight in kilograms by the height (in meters) - squared. Also, it is measured in three categories with cut points at 18 for a low BMI, between 18 and 25 for a healthy BMI and above 25 for a high BMI. The percentage of under- and overweight respondents was 1.8 and 29.5 respectively. Where there is 3.3% of the respondents' BMI is unknown and 65.4% are ‘healthy’. A Body Mass Index of 30 or higher means an individual is obese, which is associated with high mortality. The definition is based on a function of weight and height, and not on body fatness per se. But, a study in the United States, showed that BMI has been found to be highly correlated with percentage body fat (Flegal et al., 2012). However, the diagnostic accuracy of BMI in detecting obesity is limited, particularly for individuals in the intermediate BMI ranges, men and the elderly.

Furthermore, smoking is measured as the number of cigarettes consumed in one week (0 = none, 1 = 1-10 cigarettes per day, 2 = 11-20 cigarettes per day and 4 = >20 cigarettes per day).

Similarly, respondents were asked to specify this for the number of alcoholic beverages an individual has taken (0 = none, 1 = < 1 drinks per day, 2 = 1-2 drinks per day, 3 = 3-4 drinks per day and 4 = > 4 drinks per day).

Next, self-rated health is measured by the following question: “Compared to others your own age, how do you rate your health?”[1] This variable also uses five response categories (1 = much worse, 2 = bit worse, 3 = equal, 4= bit better and 5 = much better).

Finally, the way a person views his health is closely related to subsequent health outcomes such as the number of times an individual has been ill for more than one month in the last 10 years and the number of visits to a doctor or hospital in the last 10 years (Mossey & Shapiro, 1982). The following questions were asked: “How often in the last 10 years have you been ill for longer than a month?” and “How often in the last 10 years have you been hospitalized, apart from possible child-birth in the hospital?”[2] Both questions were open-ended and answers varied between 0 and 97 for the first question and 0 and 96 for the latter question.

3.3.4 Control variables

Age and gender were chosen as control variables, because both variables are known to be associated with for example BMI or smoking status (Van der Pol, 2010). Assuming that older people will increasingly experience a worse health, age influences time

[1] Hoe goed is uw gezondheid in vergelijking met andere mensen van uw leeftijd?
[2] Hoe vaak bent u in de afgelopen 10 jaar langer dan 1 maand ziek geweest?
Hoe vaak bent u in de afgelopen 10 jaar in het ziekenhuis opgenomen, afgezien van een eventuele bevalling in het ziekenhuis?

discounting as well (Read & Read, 2004). Age was measured as year of birth and later converted to the individuals' age. Differential expectations about mortality rates, risk attitude and future income levels are proved to be major explanatory factors of differences in valuing the future and explain most of the results on rates of time discounting earlier researchers have obtained (Lammers & Van Wijnbergen, 2007). Because of obvious economic explanations, education affects income, and health may determine income (Cutler & Lleras-Muney, 2006). However, income is not used as a controlling variable, because income is a result of education and it is not a useful addition to the regression analysis.

Table 3. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Female	2209	0	1	.5	
Age	2168	18	65	57.62	10.88
Education	2202	1	9	4.87	2.12
Self-rated health	2152	1	5	3.13	.7
Illness frequency	2116	0	97	.63	2.86
Hospitalization	2110	0	96	1	5.45
Alcohol consumption	2145	0	0	1.09	.95
Smoking	2145	0	3	.61	.93
Length (in meters)	2150	1.40	2.05	1.75	.1
Weight (in kg)	2142	42	185	74.05	13.43
BMI	2135	14.88	61.10	23.98	3.52
Time discounting	2209	.45	1	.94	.05

3.4 Methods

In order to measure a respondents' discount rate an individual had to participate in the experiments conducted in connection with 'Households in the Netherlands 1995' (HIN95). In total, 2209 respondents answered all six questions about time preferences. Those respondents were used in the analyses below. The result section will consist of two types of analysis.

First, the influence of time discounting on the relationship between education and health will be analyzed using tables with the Pearson Chi-Square test of independence and Kendall's Tau-b. The association between education and health is expected to reduce by controlling for time discounting. To perform the table analyses, most continuous variables from Table 1 are transformed into dummy variables. The health measures were dichotomized, alcohol consumption, smoking, illness and hospitalization, and so were education and time discounting. Self-rated health and BMI were divided into three categories.

Education is divided in two groups, lower and higher education. According to 'Centraal Bureau voor de Statistiek' (2005), in 2003 approximately 25% of the Dutch population between 25 and 64 years old is higher educated, which means a completed education of 'hbo' or higher. This amount is similar to the median in the dataset. So, here lower education consists of 'lo', 'lbo', 'mavo', 'havo', 'vwo', and 'mbo'. Respondents, with completed 'hbo', 'uni', or 'uni+' are divided into the higher educated group. Time discounting is also dichotomized, where the parameter Θ is 0 means a low discount rate and Θ is 1 means a high discount rate. The distribution is based on the median.

This method has a few disadvantages. Because of the many different ways the variables can be categorized or cross-tabulated with each other, it is possible to lose important information. Besides, no controlling variables can be included. This means that it is even harder to state any conclusions. So, two methods are used because it is an easier and more transparent way to analyze the relationship between education, health and time discounting.

Second, partial correlation coefficients are used. If a correlation exists between two variables, in this case education and health, a possible explanation is a third variable that is correlated with both variables. A partial correlation is used to control for the effect of a third variable when analyzing the relationship between education and health. If the partial correlation between education and health is smaller than the ordinary correlation, then the third variable may be partly responsible for the effect.

4. Results

4.1 Table analysis

Based on previous literature, this paper assumes that an association between education and health exists. Using a Pearson's Chi-Square test of independence and a Kendall's τ-b, the relationship between education and health is tested to see whether this assumption also holds in the selected data. A Pearson correlation is a bivariate analysis that measures the strengths of association between two variables. The value of the correlation coefficient ranges between plus and minus one. When the value of the correlation coefficient lies around plus and minus one, then it is said to be a perfect degree of association between the two variables.

A Kendall's τ- b test is a measure of correlation between two ordinal-level variables. Two observations are in the same order with respect to each variable. This test is preferred because the hypothesis assumes a direction of the association and it is not sensitive for fluctuations in the used sample size. Because a systematic distribution with low and high time discounting is used in the analyses Kendall's τ-b ensures that values will not change when the N is changed. In the next section the hypotheses are analyzed using these two measures of association.

Table 4. Association health and education

	N	**Pearson X2 test**		**Kendall's τ -b**	
BMI vs. Education					
Overall	2130	$X^2(2) = 16.12$,	p<.001	τ-b = -.08,	p<.001
Alcohol vs. Education					
Overall	2140	$X^2(1) = 1.70$,	p=.19	τ-b = .03,	p=.21
Smoking vs. Education					
Overall	2140	$X^2(1) = 28.74$,	p<.001	τ-b = -.12,	p<.001
Self-rated health vs. Education					
Overall	2147	$X^2(2) = 14.76$,	p=.001	τ-b = .07,	p=.001
Hospitalization vs. Education					
Overall	2105	$X^2(1) = 15.78$,	p<.001	τ-b = -.09,	p<.001
Ill > 1 month vs. Education					
Overall	2111	$X^2(1) = 16.06$,	p<.001	τ-b = -.09,	p<.001

Table 4 shows the results of the Pearson Chi-Square test of independence and Kendall's τ-b. Except for alcohol consumption, every health measure is significantly associated with education, where α<.05. As mentioned before, a correlation coefficient close to +1 or -1 means an almost perfect association between two variables exists. If the correlation coefficient is 0, no linear correlation between the two variables is measured.

Table 5. Association education and time discounting.

	N	Pearson X2 test		Kendall's Tau-b	
Education vs Time discounting	2202	$X^2(1) = .02$,	p=.89	τ-b = .003,	p=.89

Table 5 shows the association between education and an individuals' discount rate. The first hypothesis, a negative association exists between education and time discounting, was tested using Pearson's Chi-Square test of independence. It is expected that when the level of education decreases, time discounting increases and vice versa. The results in Table 5 show that there is no significant association between education and time discounting (τ-b=.003, p=.89). Therefore, contrary to the expectation, the first hypothesis cannot be supported.

Table 6. Tests for association of health and time discounting.

	N	Pearson X2 test		Kendall's τ-b	
BMI vs Time Discounting	2135	$X^2(2) = 13.11$,	p=.001	τ-b = .06,	p=.007
Alcohol vs Time Discounting	2145	$X^2(1) = 11.94$,	p=.001	τ-b = .08,	p=.002
Smoking vs Time Discounting	2145	$X^2(1) = .26$,	p=.61	τ-b = .01,	p=.61
Self-rated health vs Time Discounting	2152	$X^2(2) = 6.20$,	p=.05	τ-b = .03	p=.21
Hospitalization vs Time Discounting	2110	$X^2(1) = 2.18$,	p=.14	τ-b = .03,	p=.14
Ill > 1 month vs Time Discounting	2116	$X^2(1) = .94$,	p=.33	τ-b = -.02,	p=.33

As hypothesized, an association between the different measures of health and an individuals' discount rate was expected. However, the Pearson Chi-Squares test of independence is not significant for each health measure. The associations between time discounting and Body Mass Index, alcohol consumption and self-rated health are significant at the $\alpha<.05$ level, but it changes when Kendall's τ-b is being used. Still, BMI and alcohol consumption are significantly associated with time discounting, as is presented in Table 6. The hypothesis assumes a direction in the relationship, so examining Kendall's τ-b is more useful. Therefore, the second hypothesis is only partly supported.

As is shown in Table 5 and 6, no significant association exists between, education and time discounting, and time discounting and health. This means that a focus on a spurious relationship or a third variable that is correlated with both variables, in this case time discounting, is necessary.

Table 7. Association education and health, time discounting low and high.

	N	Pearson X2 test		Kendall's τ -b	
BMI vs. Education	2130				
Overall		$X^2(2) = 16.12$,	p<.001	τ-b = -.08,	p<.001
TD low		$X^2(2) = 17.30$,	p<.001	τ-b = -.11,	p<.001
TD high		$X^2(2) = 1.23$,	p=.54	τ-b = -.04,	p=.33
Alcohol vs. Education	2140				
Overall		$X^2(1) = 1.70$,	p=.19	τ-b = .03,	p=.21
TD low		$X^2(1) = .033$,	p=.86	τ-b = -.01,	p=.86
TD high		$X^2(1) = 5.07$,	p=.02	τ-b = .09,	p=.04
Smoking vs. Education	2140				
Overall		$X^2(1) = 28.74$,	p<.001	τ-b = -.12,	p<.001
TD low		$X^2(1) = 12.39$,	p<.001	τ-b = -.09,	p<.001
TD high		$X^2(1) = 19.42$,	p<.001	τ-b = -.18,	p<.001
Self-rated health vs. Education	2147				
Overall		$X^2(2) = 14.76$,	p=.001	τ-b = .07,	p=.001
TD low		$X^2(2) = 8.32$,	p=.02	τ-b = .07,	p=.01
TD high		$X^2(2) = 6.62$,	p=.04	τ-b = .01,	p=.02
Hospitalization vs. Education	2105				
Overall		$X^2(1) = 15.78$,	p<.001	τ-b = -.09,	p<.001
TD low		$X^2(1) = 11.64$,	p=.001	τ-b = -.09,	p<.001
TD high		$X^2(1) = 4.29$,	p=.04	τ-b = -.08,	p=.03
Ill > 1 month vs. Education	2111				
Overall		$X^2(1) = 16.06$,	p<.001	τ-b = -.09,	p<.001
TD low		$X^2(1) = 12.83$,	p<.001	τ-b = -.09,	p<.001
TD high		$X^2(1) = 3.33$,	p=.07	τ-b = -.07,	p=.05

The third hypothesis was tested using both measures of association. Table 7 shows the results of the correlations between health and education with and without controlling for time discounting. The last hypothesis expected that time discounting partially accounts for the relationship between education and health. Meaning that the strength of the relationship between education and health will decline if time discounting is controlled for.

The association between education and health is fully spurious if the Pearson Chi-Square disappears when time discounting is controlled for. The Kendall's τ -b is used to test for statistical dependence. The first set of overall associations, between education and different health measures, shows that in most cases there is a significant association, at the $\alpha<.05$ level, between these two variables. BMI (τ-b = -.08), smoking (τ-b = -.12), self-rated health (τ-b = .07), hospitalization (τ-b = -.09) and illness (τ-b = -.09) are positively associated with education ($p<.001$). Alcohol consumption (τ-b = .03, p=.21), shows no significant association with education, if $p<.05$. However, if time discounting is controlled for, by separate analyses for below median and above median time discounting, the strength of the associations between education and health become weaker. It can therefore be assumed that the level of education causes different health outcomes to some extent. Especially for a high time discounting, most associations between health and education are not statistically significant.

4.2 Partial correlation

Another way to analyze the third hypothesis is using partial correlations, i.e., correlations of health and education, partialling out the effect of any control variable in the first model (one for each health outcome), and partial out the effect of time discounting and control variables in the second and third model. The partial correlation between education and health, partialling out the effect of time discounting can be obtained as the ordinary (first order) correlation of the unstandardized residuals of the regression of education on time discounting and of health on time discounting. The results of the partial correlation are presented in Table 8 below.

Table 8. Partial correlations

	Model 1			Model 2			Model 3		
	N			**N**			**N**		
BMI	2135	X^2 = -.15,	p<.001	2130	X^2 = -.13,	p<.001	2130	X^2 = -.13,	p<.001
Alcohol	2145	X^2 = .13,	p<.001	2140	X^2 = .13,	p<.001	2140	X^2 = .13,	p<.001
Smoking	2145	X^2 = -.15,	p<.001	2140	X^2 = -.17,	p<.001	2140	X^2 = -.17,	p<.001
Self-rated health	2152	X^2 = .04,	p=.05	2147	X^2 = .05,	p=.01	2147	X^2 = .05,	p=.01
Illness	2116	X^2 = -.05,	p=.04	2111	X^2 = -.04,	p=.06	2111	X^2 = -.04,	p=.06
Hospitalization	2110	X^2 = -.04,	p=.05	2105	X^2 = -.04,	p=.08	2105	X^2 = -.04,	p=.08

The results of the partial correlations for the three different models are presented in Table 8. Performing a regression analysis often includes an unstandardized residuals score. Partial regression analysis means that the residuals of each score are correlated. Where in Model 1 the residuals from the regression analysis with just education and health are correlated. Those correlation coefficients were also measured with the dichotomized variables in Table 7. Due to the fact that the results in Table 7 were obtained using categorical variables compared to using continuous variables in Table 8, the correlation coefficients differ from each other. Model 2 is the correlations of the residuals from the analyses with education and the control variables and health and the control variables (age and gender). Finally, in Model 3, the residuals of the regression analyses including education, the control variables and time discounting were correlated with health, the control variables and time discounting.

As the results in Table 8 show, there are only a few minor changes between the three models. The correlation coefficients for BMI, alcohol consumption and smoking are significant in every model. Illness (p=.04) and hospitalization (p=.05) are slightly significant in Model 1, but when controlling for age and gender (Model 2) and time discounting (Model 3) the association is not significant. The differences between Model 1 and the other two models already occur in Model 2, so controlling for age and gender reduced the association between education and health. Self-rated health (p=.05), is more associated to education when controlling for age and gender in Model 2 (p=.01) and time discounting in Model 3 (p=.01). Finally, it was hypothesized that time discounting (partially) accounts for the relationship between education and health, so the association between education and health will decline if time discounting is controlled for. This hypothesis can be rejected.

5. Conclusion and discussion

This research has aimed to look at the relationship between health and education in greater depth. According to Mackenbach (2012), all countries experience systematic health inequalities between citizens with a higher and a lower socioeconomic position, as indicated by education, occupation, income or wealth. The existing literature on this association has been extensive (Cutler & Lleras-Muney, 2010). However, the literature suggested further research on the underlying mechanisms that influence these variables. The use of time discounting is a possible mechanism that could account for the relationship between health and education. The different associations between these three variables were discussed.

Satisfying arguments were found for every association. Nonetheless, there is no reason to believe that any of the relationships is causal. Still, a negative direction in the relationships was expected. In the end, it was decided that two possible models should be investigated. First, time discounting is exogenous in the relationship between education and health and influences both. Second, there is another possibility, namely that education lowers time discounting, resulting in better health because of investments in health.

Initially, the assumed relationship between education and health was tested and found significant. The first set of overall associations, shows that all health measures, except alcohol consumption, are significantly associated with education. So, this research has also found systematic health inequalities between citizens with a higher and a lower socioeconomic position, as indicated by education.

Further, hypothesis one and two were tested using Pearson's Chi-Square test of independence and Kendall's τ-b. A negative association exists between education and time discounting. Moreover, time discounting is negatively associated with different health behaviors and outcomes. Both hypotheses were rejected. This means that, contrary to expectation, higher educated individuals experience no lower time discounting and vice versa. This also applies to the expected association between time discounting and health, lower time discounting does not lead to better health.

The third hypothesis expected that time discounting partially accounts for the relationship between education and health. This means that the strength of the relationship between education and health will decline if time discounting is controlled for. Again, using table analysis with both Pearson Chi-Square test of independence and Kendall's τ-b the link between education and health was tested. The analysis was repeated for the sample, including time discounting, for both low and high. However, if time discounting is controlled for, the strength of the associations between education and health become weaker. It can therefore be assumed that, to a lesser extent, the association between education and health is partially attributable to time discounting. This analysis lacked information and the use of controlling variables. A second analysis is performed to fill this gap and control for any other important variables.

Lastly, the partial correlation coefficients were used to complement the table analyses. If a correlation exists between two variables, in this case education and health, a possible explanation is a third variable which is correlated with both education and health. If the partial correlation between education and health is smaller than the ordinary correlation, then the third variable may be partly responsible for the effect. The correlation coefficients for BMI, alcohol consumption and smoking are significant in every model. This means that in this research the association between education and BMI, alcohol consumption and smoking does not change if age, gender and time discounting are controlled for. Other third variables may be accountable for these relationships. Another possibility is the existence of an actual causal relationship between an individuals' educational level and their Body Mass Index, alcohol consumption and whether one smokes or not. Illness and hospitalization are associated with the level of education, although to a lesser extent compared to the other health measures. But, when controlling for age and gender in the second model, and time discounting in the last model, the association is not significant anymore. Controlling for age and gender reduced the association between education and health. When controlling for age and gender in the association between education and self-rated health, the correlation coefficient becomes (more) significant. This is also due to the addition of age and gender, not time discounting. This means that time discounting cannot account for the association between education and self-rated health, illness and hospitalization. So, also the third hypothesis was rejected. The few differences in correlation coefficients are probably due to the addition of age and gender in Model 2.

Thus, given this plausible theoretical third-variable relationship, it is interesting to see that controlling for time discounting did not lower the strength of the relationship between education and health by that much. In other words, the relationship between education and health is not due to time discounting.

For future research it is important to look in greater depth at the two different models which are discussed. Normally, to find a more convincing answer to the question which way the relationship between education, health and time discounting works, cross sectional data cannot be used. The use of cross-sectional data meant it was not possible to test whether time discounting is exogenous or whether the increase in health was a result of education lowering a persons' time discounting. Further research attempting to allow for the potential endogenous relationship between education and time discounting is clearly required.

The questions used to estimate time discounting varied in terms of time of delay and magnitude. This is called the magnitude effect: discount rates are lower for large magnitude outcomes. Thus, someone may prefer €10 now to €15 in one year but also prefer €1.500 in one year to €1.000 now, even though both choices offer a 50% return for waiting one year (Chapman & Elstein, 1995). Questions 3 and 5 were clear examples of the magnitude effect. A relative low value for x_1 resulted in higher values for x_2 compared to the other questions. Further research should focus on refining the measurements of time preference methods.

Other variables, such as genetic differences, which the analysis could not control for are obviously left out of the analyses. Unfortunately, no valid instruments are available and an instrumental variables approach could not be used. For example, this paper did not explore the role of risk attitude. Further research is needed to look at this association, so countries can do something about the systematic health inequalities across different social groups that exist everywhere.

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