The health effects of education: survey and meta-analysis*

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Keywords: education, health

Abstract

In this paper a survey and a meta-analysis of the literature on the relation between education and health is presented. Both the survey and the meta-analysis show that there are strong links between education and health. A crucial question is whether education has a causal effect on health, or not. Our reading of the literature is that the effect of education on health represents a genuine causal effect, that the reverse effect running from health to education is relatively small (at least for adults), and that there are common factors – most notably time preferences – that affect both investments in health and education. The results of the meta-analysis show that the QALY weight of a year of education is approximately 0.02. Some tentative calculations suggest that the cost-benefit ratio of investments in education on health is highly positive. For public policy this implies that a more integrated approach to education and health policies should be taken.

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Abstract

In this paper a survey and a meta-analysis of the literature on the relation between education and health is presented. Both the survey and the meta-analysis show that there are strong links between education and health. A crucial question is whether education has a causal effect on health, or not. Our reading of the literature is that the effect of education on health represents a genuine causal effect, that the reverse effect running from health to education is relatively small (at least for adults), and that there are common factors – most notably time preferences – that affect both investments in health and education. The results of the meta-analysis show that the QALY weight of a year of education is approximately 0.02. Some tentative calculations suggest that the cost-benefit ratio of investments in education on health is highly positive. For public policy this implies that a more integrated approach to education and health policies should be taken.

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1. Introduction

Education and health are the two most important characteristics of human capital. Their economic value lies in the effects they have on productivity: both education and health make individuals more productive. Education and health have a considerable impact on individual well-being, as well. The wealth of nations is to a large extent determined by the educational attainment and the health status of its population.

There is large evidence to support the claim that there is a positive relation between education and health. Some of this evidence is surveyed in Grossman & Kaestner (1997). This survey concludes that “A number of studies in the United States suggest that years of formal schooling completed is the most important correlate of good health” (Grossman & Kaestner 1997, p. 73). Not only in the US, but also elsewhere – and in particular in developing countries – the positive association between education and health is well documented. According to the 2003 Human Development Report “Education, health, nutrition and water and sanitation complement each other, with investments in any one contributing to better outcomes in the others” (UN 2003, p. 85).

Table 1 summarizes some statistics taken from the 2003 Human Development Index of the United Nations (UN 2003). The figures show large differences in education and health outcomes between countries. They also clearly suggest that there is a positive relation between educational attainment in a country – as measured by the net enrollment ratios on primary and secondary education – and health – measured by life expectancy at birth and the infant mortality rate.

The positive association between education and health can be partly attributed to differences in income between countries. Health and prosperity are positively

related. For example, Behrman & Rosenzweig (2004) show that there is a strong negative association between the log of purchasing power parity adjusted GDP per worker and the percentage of low birthweight babies. Low income countries have fewer resources to spend on publicly financed education and health care. Most individuals in low income countries also do not have the means to purchase education and health care themselves. On the other hand, investing in education and health provide the way out of poverty and are necessary conditions for increasing standards of living.

There are three potential explanations for the positive relation between education and health: 1) a better health enables one to invest more in education, 2) common factors – such as genetic endowment, social background or time preferences – affect health and education in a similar way, and 3) education leads to a better health. In this survey we focus on this third effect.[1]

In their survey of non market outcomes of education, Wolfe & Zuvekas (1997) identify five health and health related effects of education:

- A positive relation between ones education and one's own health status;
- A positive association between schooling and the health status of one's family members (in particular on one's children);
- A positive link between one's own schooling and the schooling received by one's children;

1 Education affects health, but investments in health and education also have some common attributes, as argued by Theodore Schultz in his seminal paper *Investment in Human Capital*: Education as well as health expenditures are both consumption and investment. Returns to investments in education and health are uncertain. There are third-party effects involved in both education and health. And the involvement of the public sector in the provision of education and health care is large.

- A positive contribution of schooling to the efficiency of (consumer) choices (f.e. on smoking and on the use of health care);
- A relation between schooling and one's own fertility choices and the fertility choices of one's children (in particular a negative effect on the probability of giving birth out of wedlock as a teenager).

There is an abundance of empirical evidence, mainly from the epidemiological and social science literature, on the relation between socio-economics status (SES) - measured by educational attainment - and health. There are at least three reasons why a new survey of the literature contributes to our knowledge in this field. First, in recent years new evidence has been published on the relation between education and health. These studies not only pertain to the effects of education on health but also shed light on the importance of infant health on subsequent educational attainment. Also recent studies have more explicitly studied causality issues in the relation between education and health. A second reason is that until now a systematic survey or meta-analysis of the relation between education and health is not available. Finally, the size of the effect of education on health has never been quantified.

Hunt-McCool & Bishop (1998) argue that the fields of education economics and health economics have bifurcated because of the difficulties in valuing inputs and outputs, and that no (monetary) metric exists to measure health outcomes. Our study aims at providing a bridging this gap again by providing a meta-analysis to quantify the effect of a year of education on individual health status.

In the first part of this paper the literature on the effects of education on health is surveyed. In particular we look at the evidence of the effects of education on infant

mortality and adult longlevity, quality of health and health behavior. In the second part of the paper we present a meta-analysis of studies that use a self-evaluation on the quality of health ('How would you describe your health?') to analyze the education effects on health.

For simplicity the terms 'education', 'schooling' and 'learning' are sometimes used interchangeably and without clear demarcation in this paper, except when necessary for a clear understanding of the meaning of the relation with health outcomes. Similarly we use a multitude of health outcomes: mortality and life expectancy, morbidity and the incidence and prevalence of diseases and handicaps, and self-assessments of the quality of health.

2. How does education contribute to a better health?

Several mechanisms can be distinguished by which education leads to a better health. The health investment model of Grossman (1972) offers one explanation for the relation between education and health. In this model education lowers the shadow price of health capital which increases the demand for health capital (higher educated people attach a greater value to a longer life expectancy and a better quality of life). However, Grossman (1972) shows that the derived demand for the factors of health capital production – i.e. prevention and healthy behavior – only increase in education if the price elasticity of the demand for health capital is larger than one. Further, higher educated people are able to earn more in the labor market. The higher wages higher educated are able to earn increase the opportunity costs of unhealthy behavior. A third mechanism by which education affects health is that

higher educated people have more knowledge and information about health and healthy behavior.

A more specific listing of the various ways in which education contributes to a better health is found in Feinstein et. al (2003). This study distinguishes six channels by which education affects health:

- Effects due to the development of specific skills. Courses on health promotion or health safety which may have a direct impact on health.
- Generic cognitive development. Cognitive skills, such as reasoning and the ability to gather and process data, may be helpful in acquiring, interpreting and the application of information on health behavior.
- Personal development. The development of psychological resilience, self-efficacy and well-being through education may enhance the capacity to initiate and maintain health behavior. Also other personal characteristics that are fostered by educational achievements, such as self-esteem, a positive outlook on the world and motivation may contribute to health behaviour
- Peer group effects. Mixing with others that have acquired the above mentioned specific skills, cognitive and personal development may provide a supportive context in which the individual attitudes and social norms encourage health behaviors.
- Positional effects. Education increases status. A higher status may lead individuals to identify more with attitudes, norms and behavior that improve health.
- Economic effects. Education increases human capital and human capital increases the (lifelong) earnings potential. A higher earnings potential

increases the opportunity costs of unhealthy behavior and increases the returns to investments in health behavior. Consequently investments in education and in health complement each other.

Similar factors through which education affects health are distinguished in Hammond (2003). This study identifies four linkages between education and health outcomes:

- Economic factors: A higher education increases the earnings potential. This enables individuals to adopt a healthier life style and to purchase better health care. One way by which high income individuals buy a healthier life style is by trading some of their earnings for lower health hazards at work (i.e. a safer work environment);
- Access to health services: Higher educated people are more informed about quality and access to health and are more articulate and assertive in receiving the health care they need, when they need it.
- Health related practices. Higher educated people are more likely to lead a healthy life style, i.e. eating enough fruit and vegetables, exercise, use alcohol moderately, do not smoke, etc. Higher educated people are more informed about the health risks that are associated with unhealthy life style. A higher education is also associated with a lower time preference, making that higher educated people are more likely to defer immediate gratification for more benefits in the future.
- Coping with stress. This pertains to the argument that a higher education enables people to cope better with stress and that "… education develops psychosocial qualities that contribute to resilience" (Hammond 2003, p. 72).

Next to the 'what' question there is the question how to educate non-economic benefits of education such as health? Preston & Hammond (2002) surveyed 10,000

practitioners in education throughout England about their opinions about aspects of student's experience which might be expected to best deliver non-economic benefits (such as health benefits). The most cited experience that delivered non-economic benefit were interaction between students, course content and responsibility for own learning. Sense of purpose and teaching style were also frequently mentioned as sources of non-economic benefits.

3. Methodological problems in determining the effect of education on health

Many studies on SES or education and health by epidemiologists and social scientists analyze associations between education and health and either ignore or simply assume a causal relation between the two. Fairly few studies address whether this association really reflects a causal relation. The relation between education and health is merely a correlation and not a causal relation if:

a) There is a joint relation between education and health, whereby education not only affects health but there is also a reverse causality where health determines investments in education. A reverse effect would creates a positive simultaneity bias in measuring the effect of education on health.

b) There are other factors – i.e. variables that are either not observable or not observed - that affect both education and health.

The causality question is important, not only for determining the exact relation between education and health, but also from a policy point of view. Only if the relation between education and health is a true causal relation a shift in (public)

expenditures from health care to education can be effective in improving both the level of education and the health status of the population.

Acemoglu, Johnson & Robinson (2003) argue for a reverse causality between education and health. A shorter life expectancy because of poor health conditions shorten the time horizon of individuals. A shorter time horizon lower the returns and therefore the investments in human capital such as education. Furthermore, children who are in poor health are less able or have less energy to attend school, while workers with poor health may be less inclined to invest in on-the-job training.

One reason why a reverse causality might only be a minor source of bias when estimating the relation between education and health is that educational attainment is essentially established in early adulthood and remains stable afterwards. Most health impairments are not incurred until an adult age, however. Of course, especially in less developed countries, child mortality and morbidity is a cause for concern, infant and child health for most children in developed countries does not impart on their educational attainment.

The latter view is supported by the argument in Hammond (2002). There it is argued that the link between education and health increases with age, i.e. that the association is stronger among older populations than among younger people. This is explained by the fact that some health behaviors – such as not wearing a seat belt or condom – constitute a constant risk to health, whereas others – such as smoking and excessive alcohol use – constitute a cumulative risk. This means that the education differential in the latter type of unhealthy behavior is only translated into observable physical health differences later in life (Hammond 2002, p. 557). Empirical support for this claim is found is Groot & Maassen van den Brink (2004a). This study finds that

the effects of education on self-assessed health become stronger as people get older.

The effects listed in Feinstein et. al (2003) – and that were summarized above – provide causal mechanisms in the relation between education and health. Grossman & Kaestner (1997) argue that the causality in the effect of education on health arises because higher educated people are more efficient in maintaining and fostering their health. Or, as they express it, higher educated people produce health more efficiently.

Grossman & Kaestner (1997) distinguish between two forms of efficiency in the production of health: productive efficiency and allocative efficiency. Productive efficiency refers to the situation whereby higher educated people are able to obtain higher health benefits from the same amount of inputs. One example is that health benefits of the consumption of healthy food (vegetables, fruit, etc.) are higher for higher educated people. Allocative efficiency refers to the fact that higher educated people are more informed about the health effects of certain inputs. One example is that higher educated people are more informed about the health effects of (healthy) food.

According to UN (2003) a cross country comparison over time shows that increases in educational attainment precede improvements in health status (UN, 2003, p. 87). This temporal sequencing suggests a causal relation between education and health. As argued above, the causal relation between education and health arises because a higher education leads to a healthier life style and because higher educated people are better able to gather, to process and to interpret information about healthy behavior. Becker & Mulligan (1994) add a third causal

mechanism to this. They argue that education leads to a lower time preference for consumption in the present and a higher time preference for consumption in the future: “Schooling also determines …..[investments in time preference] partly through the study of history and other subjects, for schooling focuses students’ attention on the future. Schooling can communicate images of the situations and difficulties of adult life, which are the future of childhood and adolescence. In addition, through repeated practice at problem solving, schooling helps children to learn the art of scenario simulation. Thus, educated people should be more productive at reducing the remoteness of future pleasures” (Becker & Mulligan 1994, p. 10).

Education may alter time preferences, but a lower time preference may cause individuals to invest more in education and health as well. So, time preferences may be an intermediate in the relation between education and health – as argued by Becker & Mulligan – but may also be a common (unobserved) causal factor for both investments in education and health. Fuchs (1996) argues that education is correlated with time preference, and that it is time preference that affects health rather than education. This hypothesis is tested by Sander (1998). This study includes cognitive ability and future education as covariates in an equation where smoking and marijuana is explained by college attendance. Future education and cognitive ability are viewed as correlates of time preference. This study finds both support for the argument that education affects health and for the hypothesis that time preference matters.

As was mentioned above, fairly few studies actually test whether the effect of education on health is a causal relation. Most of the studies that do test for causality, use some sort of 2SLS with appropriate Instrumental Variables for education to test

whether the effect of education on health is truly a causal effect. Aside from the fact that good quality instruments for education are difficult to obtain and that many of the IV studies suffer from the limitations caused by weak instruments, IV variables estimations enable the researcher to reject the hypothesis that the effect is a causal effect but the reverse – that it is indeed a causal relation – is almost always difficult to prove. This makes that the IV estimations are biased towards rejecting the notion that education causes better health.

4. Lifelong learning and health

Educational attainment and life expectancy

The relation between educational attainment and mortality and life expectancy is well-documented. Two lines of research can be distinguished. The first approach uses cross-country data and relates the average educational attainment in a country to mortality rates and life expectancy. One example is the study of Berger & Messer (2002) which uses mortality data on twenty OECD countries for the period1960-1992 and finds that a higher percentage of the population with post-secondary education in a country reduces the mortality rate. Some of these cross-country studies are surveyed in McMahon (1999). He concludes that "….. lagged female primary and secondary education rates account for substantial reductions in infant mortality (after controlling for per capita income), as well as significant increases in longlevity worldwide" (McMahon 1999, p. 91). This survey further clearly suggests that the effect of (mother's) educational attainment is largest on the reduction of infant mortality. Education has an effect on life expectancy as well, but the size of this effect

is much smaller than the effect on the reduction of infant mortality. So, the effect of education on longlevity seems to run primarily through its effect on infant mortality rates.

The second approach uses changes over time within one specific country or differences in mortality rates between people with different levels of education to identify the effect of education on life expectancy. For example, according to Van Oers (2003), life expectancy in the Netherlands for men with the lowest level of education is 5.0 years less than men with a university education. For women this difference is 2.6 years. Elo & Preston (1996) find for the United States large effects of education on mortality as well. For working-age men the ratio of death rates between the lowest and the highest education level is 2.22. For women education has a somewhat smaller effect: here the ratio between the highest and the lowest education level is 1.79. This study not only finds that education effects on mortality are larger for men than for women, but also the effects are larger during working ages than at age 65 and above. A third conclusion of this paper is that the reduction in mortality of an additional year of education in the United States is comparable to those estimated for a number of European countries (see also, Valkonen 1989). For example, using data for the Netherlands, Bosma et. al (1999) find that the risk of dying for people with only primary education was 2.64 times higher than the risk for the highest education group. This suggests that the education effects do not appear to represent differences in access to health care and differences in the organization of health care.

Education and quality of health

A few studies have looked at the direct effects of education on the quality of health. These studies provide the input for the meta-analyses provide in Section 5. Almost all of these studies show that education strongly contributes to a better health. Grundy & Sloggett (2003) show that this education effect is persistent. This study uses a variety of health measures and finds that educational qualifications obtained at a young age have an effect on health status when people are aged 65-84. Among others, education reduces the probability of psychiatric morbidity, suggesting a link between life circumstances and development, and psychological well-being in later life. Welle et. al (2004) find among a sample of the Norwegian population that for males a lower education is an independent risk factor for lung capacity or, more specific, of the single-breath carbon monoxide transfer capacity of the lungs.

Education may not only have a direct effect but also an indirect effect on health. Antonucci et. al (2003) analyze whether social relations, especially with children, mediate or moderate the relation between education and health for middle aged and older parents. They find that lower educated men, but not women, had fewer health problems if they have larger networks or if they perceived that emotional, financial and sick care support was available from a child. For higher educated men social relations seem to have much less impact on the association between education and health. As a higher education also contributes to the size of one's social network and social capital (see Groot, Maassen van den Brink & Van Praag 2004), this reinforces the relation between education and health. Similarly, Wolfe & Zuvekas (1998) argue that education may increase health because of occupational choices (higher educated people choose occupations with relatively

lower hazards) or location choices (higher educated people choose to live in less polluted areas).

Intergenerational transfer of human capital: The education level of the parents

Some studies have looked at the effects of parental education on the health status of their children. A distinction has to be made between the effects of parental education on infant health and the effects on health when children have reached an adult age. The effects of parental education on infant health is particularly important in developing countries with a relatively high infant mortality rate. One study, using data for Brazil finds that maternal education is associated with infant mortality but also with later outcomes such as hospital admissions, length-for-age and weight-for age at mean age 20 months (Victoria et. al 1992).

Parental education may affect both the education level and the health status of the children. Children with higher educated parents are more likely to attain a higher education level themselves. Higher educated parents are better informed about what is good for the health of their children. They also attach a higher value to their children's health. Little is known about the effects of parents' education on the health status of their children. One exception is Leigh (1998). This study finds that – if the education level of the respondent is not controlled for – health is determined by the education level of the mother but not by the education level of the father. If the own education level is controlled for, this study no longer finds a statistically significant relation between parental education and health. Similar findings are reported by Groot & Maassen van den Brink (2004). These findings suggest that the education level of the parents has an indirect effect on health – through the education level of

the respondent - but not a direct effect. This study further suggests that mother's education is more important than father's education.

Most studies find no effect of parental education on the adult health status of their children, once we control for the education level of the child. If the own education level of the child is not controlled for, it seems that mother's education level has a positive effect on her children's health status at an adult age. Father's education appears to have no statistically significant effect. The latter finding suggests that the effect of parental education does not reflect an effect of genetic endowment. If that we the case, the education level of both parents should have had a significant effect. The former finding indicates that the effect of parental education – if any – runs through the educational attainment of the child itself: higher educated parents have children that attain a higher education level themselves and higher educated individuals are generally in better health.

The effect of infant health on subsequent educational attainment

A higher education level of the parents generally contributes positively to health at birth (birth weight) and to the health status of infants and young children. This is important because birth weight and infant health are important for subsequent adult educational attainment. After controlling for father's social class and mother's education, Richards et. al (2001) find in a British birth cohort of 1946 that birth weight was associated with education, with those of higher birth weight more likely to have achieved higher qualifications. Similar conclusions are drawn by Corman & Chaikind (1998). This study finds that low birth weight children are more likely to repeat a grade in school and are more likely to attend special education classes, even when holding constant the current health status of the child. Behrman & Rosenzweig

(2004) use data on monozygotic twins in the US to analyze the returns to birth weight. They find that a child's fetal growth and his or her subsequent schooling attainment are significantly and positively related. Efforts taken by a mother to increase fetal growth such that birth weight is increased by 1 lb. at birth (an increase of fetal growth of 0.4 oz./week) results in almost a third of a year more schooling for her child. Similar conclusions are drawn by Paz et. al (1995) and Pharoah et. al (2003). The latter study finds that children with a low birth weight (< 1500 g) perform significantly less well on a General Certificate of Secondary Education exam in Britain at age 15 than a matched comparison group. Paz et. al (1995) compares the educational attainment of adolescents who were born small for gestational age (weight at term birth below the third percentile) and those who were born with average weight for gestational age. Males born small for their age were found to have lower educational qualifications. They had a risk of having less than 12 years of schooling or attending vocational education 2.4 times greater than men born with average weight for gestational age.

Education and health behavior

Major differences in life-style occur when children reach their teenage years. This coincides with the transition of children from primary to secondary education. It is then that we observe differences in healthy and unhealthy life-styles between children in lower secondary education and those who attend higher secondary education. For example, in the Netherlands at age 15 twice as many teenagers attending lower secondary education smoke cigarettes than among youngsters in higher secondary education. Similar figures for the US are presented in Sander (1995). The figures presented in this paper show that the percentage smokers among

college graduates at age 20 or older is more than twice as high as the percentage smokers among people with less than high school. This study further shows that education has an effect on whether one smokes, but not on the number of cigarettes smoked. At the mean value of years of education and the smoking percentage, the education elasticity of smoking is –4.9, implying - according to Sander (1995) - that at 10% increase in years of education reduces the incidence of smoking by 4.9%.

Grossman & Kaestner (1997) present an overview of studies on the relation between education and health. This survey shows that higher educated people are less likely to smoke, exercise more, wear seatbelts more often, and are more likely to participate in screening programs for breast cancer and cervix cancer. We can conclude from this survey that higher educated people generally have a healthier life style. The only exception is alcohol use: in most countries the higher educated consume more alcohol than the lower educated.2 As a consequence of their unhealthier life style, lower educated people generally report more health problems and make more frequent use of health care arrangements.

A positive relation between education and healthy behavior is found in many other studies as well (for a review, see Lenthe, Droomers, Schrijvers & Mackenbach 2000). In Nayga (2000) it is found that more health knowledge decreases the likelihood of overweight. If someone is fully informed about the relation between nutrition and health, this reduces the probability of being overweight by 20%. If health education is not controlled for, years of education reduce the probability of being overweight. If health education is taken into account, years of education cease to have a statistically significant effect, however. In this study it is further found that higher educated people possess more health knowledge.

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2 However, many studies show that moderate alcohol consumption has positive effects on health (mortality), labor productivity and employment opportunities.

Feinstein (2002) uses data from UK national cohorts to estimate the effect of education on obesity and depression. After controlling for a number of covariates this study finds that going from no qualifications to an academic level reduces the probability of depression by 6 to 10 percentage points. Smaller effects are found for obesity. For men a change from no qualifications to an academic degree reduces the probability of obesity by 5-7 percentage points in some cohorts but not in others. For women a similar change in education reduces the probability of obesity by 5 percentage points in only one of the cohorts studied.

Adult learning and health

The effect of adult learning on health is a little researched area. One of the few exceptions is Feinstein et. al (2003). This study looks at the effects of work-related, vocational, academic, leisure oriented and other types of adults learning courses on a variety of health outcomes. The health outcomes include: whether smokers gave up smoking; whether those depressed at age 33 had recovered from that depression at age 42; whether those not depressed at 33 were less likely to become depressed; and on whether or not people increased their level of exercise and alcohol use. They finally considered the effect on life satisfaction. The authors use longitudinal data to estimate fixed effects models on the six outcome variables. They find that participation in adult learning has positive effects on the decision to give up smoking and on taking more exercise. Taking two courses in adult education increases the probability of giving up smoking by 3.3 percentage points. This corresponds to a relative increase in stopping with smoking of 15%. Adult education appears to have no effects on the onset or the progression of depression. Vocational and leisure

courses reduce alcohol consumption, but work-related courses increase alcohol intake.

The nature and causality of the effects found in this study are disputable. Although the authors use a fixed effects model to eliminate common individual unobserved factors that determine both participation and health outcomes, it is unclear whether the effects really represent causal effects. The authors test for a reverse causality by running regressions backward, i.e. from health outcomes on the participation in adult learning courses. They conclude that changes in most of the health outcome variables are involved in a process of progression: participation in adult learning courses leads to changes in health outcomes, and these changes lead in turn to further participation in more learning.

5. A meta-analysis of the effect of education on self-perceived health

Many studies on the effects of education on health use a self-assessment of the individual's health status as the health outcome variable. In this section we use these studies for a meta-analysis of the QALY weight effect – a health outcome measure that is derived from responses to a self-report of health - of education. We use studies that use self-assessed health status as input for a meta-analysis on the effects of education on health. We combine studies that explicitly look at the effects of education on self-assessed health status with studies in which self-reported health is an outcome measure and education is one of the control variables, but in which the relation between the two is not the main object of study in the paper.

Self-reported health (SRH) is frequently measured by a question that asks respondents to rate their overall health on a five point scale from excellent to very poor. The general subjective health question runs like: “How would you describe your health in general?” According to Fayers & Sprangers (2002), “There is widespread agreement that this simple global question provides a useful summary of how patients perceive their overall health status. This view is also borne out by the large number of studies that have consistently shown, in a wide range of disease areas, that SRH is a powerful predictor of clinical outcome and mortality.”

Some of the studies in the meta-analysis use an age-related question on subjective health rather than a general question. The age-related question typically runs like: “Compared to people your age, how would you describe your health?” These age-related self-reported health questions may introduce a source of age norming bias in the results (see Groot 2000). Baron-Epel & Kaplan (2001) examine differences in response to a general subjective health question and an age-related one. They find that agreement in responses between the two questions is poor among elderly people aged 65-75. Agreement in responses is excellent, however, among people aged 55-64. They also find a statistically significant effect of education on health only when the age-related subjective health question is used, but not when the general question is used.

Unfortunately, not all studies that analyze the effects of education on self-assessed health could be included in the meta-analysis. Quite a number of studies from the medical field use logistic regression to analyze relationships. A typical example of this approach is Monden et. al (2003). This study uses almost 40,000 individual observations from the Netherlands to test the importance of own and partner

education on self-assessed health. This study finds that people with primary education are three to four times more likely to report themselves to be in a less than good health than people with a tertiary education level. Respondents with a partner with only primary education are about 1.5 times more likely to be in less than good health compared to respondents with a partner having a tertiary education level. Similar findings of the effects of one's own education on self-assessed health are found using data for Israel by Baron-Epel & Kaplan (2001), for eleven Western European countries by Huisman et. al (2003), for a similar number of European countries by Carlson (2004), for Finland and part of Russia by Heistaro et. al (2001), for seven central European countries by Bobak et. al (2000), for Finland by Rahkonen et. al (1997), for Thailand by Zimmer & Amornsirisomboon (2001), for the United Kingdom by Cooper (2002), for Polish women by Wróblewska (2002), for Bulgaria by Balabanova & McKee (2002), and for British and Finnish women by Lahelma et. al (2002). And this is only a selection of the studies that use a general subjective health measure as an outcome variable and multivariate logistic regression to relate education and health.

The limitation of these kind of studies using logistic regression analysis is that they only report odds ratios for different levels of education, i.e. how many times a lower education increases the probability of being in less than perfect health. These studies, unfortunately, only provide information on the relative effect of education on health and of the absolute health effect of education. It is the latter kind of information that we use in our meta-analysis.

Calculating the QALY weight of education

In the empirical modeling of the quality of health three concepts are distinguished. The first is the true quality of health H^*. The true quality of health is a latent variable that can not be observed directly. What we observe are an objective measure of the health status of the individual, denoted by H^o, and a subjective measure of the quality of health, H^s. The objective health measure refers to the prevalence of illnesses and handicaps. H^o refers to a vector of control variables on illnesses and handicaps. The subjective measure of health, H^s, is measured by the response to the self-evaluation question. In the most general specification the latent quality of health variable is further determined by the number of years of education S_r, the years of education of both parents S_p and S_m, income Y, the prevalence of diseases and handicaps and other control variables X:

$$H^* = b_0 + b_1 S_r + b_2 S_p + b_3 S_m + b_4 Y + H^o b_5 + X b_6 + e$$

where ß are vectors of coefficients and e is a standard normal distributed random term capturing unmeasured and unmeasurable effects on the true health status.

Two approaches to the estimation of the coefficients can be distinguished. The first treats the subjective health status as a continuous variables and estimated the above equation by OLS. In the second, the observed health status H^s is treated as a categorical ordered response variable. The observed health variable is assumed to be related to the latent variable in the following way:

$$H^s = i \leftrightarrow a_{i-1} < H^* \leq a_i, \quad i = 0,....,n$$

where n is the number of response categories (i.e. n ranges from 1 to 5 for most subjective health measures used in the studies) and a_i are threshold levels that demarcate the different response categories. If we further assume that $a_0 = -\infty$ en $a_n = \infty$, we get the specification of the ordered probit model (McKelvey & Zavoina 1975).

Cutler & Richardson (1997, 1998) calculate QALY weights from the estimates of the $ß_1$ coefficients in the ordered probit model. Let $ß_1$ be the coefficient that represents the impact of a year of education on health. As the ß coefficients are not scaled and can range from $-\infty$ to ∞, the $ß_1$ coefficient needs to be normalized to produce a QALY weight. Following Cutler & Richardson (1997, 1998) we normalize by dividing by the difference between the borderline between excellent health and that of a very poor health. In this it is assumed that an excellent health corresponds to a near perfect health and a very poor health corresponds to near death. The QALY weights are defined as:

$$QALY = \frac{b_1}{a_4 - a_1}$$

In the OLS estimates the QALY weight are simply determined by the marginal effect education on health as represented by the β_1 coefficient.

The results of the meta-analysis

Descriptive information about the studies included in the meta-analysis are found in Table 2. We are able to include 18 studies.3 These studies provide 31 estimates of the QALY weight of education. We further derive information from these studies on year of data collection, the country for which the data were collected, the econometric method (OLS or ordered probit), sample selection characteristics like gender (male, female, or both genders), and age group (all age groups, people aged 60 and over, people younger than 60), the inclusion of control variables for income or parental education, the measurement of the education variable (dummy variables or years of education), the outcome measure (whether or not it asks respondents to evaluate their health compared to someone of their own age), whether the education effect is statistically significant and the size of the QALY weight of a year of education. If the education variable was measured by dummy variables, the dummy variables were converted to years of education (for details, see the note below table 2).

Some descriptive statistics of the average QALY weight effect of the studies in the meta-analysis are found in Table 3. The unweighted sample average QALY weight effect of a year of education is 0.018 with a standard deviation of 0.010, i.e. a year of education increases the QALY weight on a scale from 0 to 1 by 0.018 points. Extrapolating this result, four years of college increases quality of health by about 0.072 points.

The average QALY weight effect of a year of education is about two third higher in studies using data for the United States (average QALY weight is 0.025) than in studies using data on European countries or Canada (0.015). OLS estimates

3 Studies were collected by a search in ECONLIT and MEDLINE. Key words in the search in ECONLIT include: ‘self-reported health’, ‘self-assessed health’ and ‘subjective health’. The search terms used in MEDLINE were ’self-assessed health and education’, ‘self-reported health and education’, ‘subjective health and education, ’self-assessed health and schooling’, ‘self-reported health and schooling’, and ‘subjective health and schooling’.

of the education effect on self-reported health variable are about twice as high (0.024) than the size of the effect in an ordered probit regression (0.012).

For the demographic variables – gender and age group – we find that the QALY weight effect is smallest in studies that only use observations on males (0.016). In studies using data on females (0.020) and studies that use a combined male and female sample the average QALY weight effect is somewhat larger (0.019). In studies that use observations on individuals younger than 60 years the QALY weight effect is somewhat larger (0.022) than in studies that use an elderly sample or a sample including individuals of all ages (0.015 and 0.017, respectively).

One would expect that the inclusion of education or parental education would lower the QALY weight effect of education, as without these controls the education effect may pick up some of the income and social background effects on health as well. This is not what the results of the meta-analysis show, however. The average QALY weight effect of a year of education is somewhat higher in studies that include controls for income or parental education (0.019) than in studies where these variables are not included (0.017).

The specification of the education variable in the equation does not appear to matter much. In studies that use dummy variables for education the average QALY weight is 0.017, while in studies that use years of education it is 0.019.

The average QALY weight effect in studies in which the respondent is asked to compare his/her health with others of the same age is somewhat lower (0.012) than in studies without this age norming (0.020).

The descriptive statistics show differences between studies by country, econometric method and gender. Sample means, however, tell us little about the sources of

heterogeneity in the QALY weight estimates within and between studies. As argued by Thompson & Higgins (2002) the appropriate analysis of the heterogeneity in meta-analysis is a random effects meta-regression.

The two last columns of table 3 contain the random effects regression estimates with the QALY weight effect as dependent variable. In a first round all of the above mentioned variables are included in an random effects meta-regression. As the number of observations is small relative to the number of variables in the meta-regression, we also present results of a more economical model, i.e. a model which only includes variables with a t-value larger than 1.

If we include all variables, four have a statistically significant effect: the country dummy, the variable for the econometric method, the male gender dummy and the dummy variable for controls for income or parental education. If we only include variables with a t-value larger than one, only two variables have a statistically significant effect: the country dummy and the dummy variable for the econometric specification. We find that the QALY weight effect is 0.008 higher in studies using data for the United States than in studies using data on European countries or Canada. We further find that in studies that use ordered probit regression the QALY weight effect of a year of education is 0.009 lower than in studies that use OLS.

Controlling for income or parental education does not appear to have a statistically significant effect on the QALY weight, at least in the reduced model. We also do not find any statistically significant differences between studies that use data on males, females or both genders.

Finally, controlling for country, econometric method and gender yields an QALY weight effect of a year of education of 0.023 (the intercept term in the regression).

Testing for causality

As in all studies on the effects of education on health, the causality issue also pertains to the studies included in our meta-analysis. Only three of the studies in our meta-analysis – Adams (2002), Arendt (2004) and Groot & Maassen van den Brink (2004) - test for endogeneity of the education variable in the health equation. Adams (2002) concludes that the education effect on health is independent of the influence of omitted variables. He concludes that even after correcting for endogeneity bias, the education effect on health remains positive and statistically significant. Arendt (2004) draws different conclusions. This study finds that when endogeneity is allowed for, the relation between years of education and self-reported health increases in magnitude. However, as is found in many IV studies, the standard errors increase as well. It is concluded that it can not be rejected that education is exogenous to health, nor can the null hypothesis of no effect of education be rejected. This study is therefore inconclusive about the education effect on health. Groot & Maassen van den Brink (2004) find that IV estimates differ between women and men. For men instrumental variables doubles the effect of a year of education on quality of health, while for women IV yields a statistically insignificant parameter estimate for years of education. Next, this study tests whether it is necessary and useful to use IV (the relevance of the instruments), whether we have used the right instruments (the validity of the instruments) and whether the quality of the instruments is good enough. It is concluded that the instruments are valid and of good quality, but that it is not relevant to use instrumental variables.

Cost-benefits of education

The final question to ask is whether it is cost-effective to invest in education to improve health. If a year of education improves QALY by 0.023, this is equal to 43 years of education for 1 QALY. At the margin, the costs of a year of education are about Euro 6,000 (OECD 2001, p. 67). The costs per QALY then amount to about 258,000 Euro. Of course, this only pertains to the costs on education in order to obtain a QALY worth of health gain, while education has wider benefits – i.e. it improves earnings, well-being etc. – as well.

The costs per QALY have to be compared with the life-time value of a QALY in order to determine whether investments in education are welfare improving. To calculate the monetary value of the education effect of the quality of health, we use the literature on the value of a QALY. A much used measure for the value of a QALY is Laupacis et. al (1992). This study calculates that the value of a QALY is about $ 100.000.4 This is roughly equal to Euro 90.000. At a 5% discount rate and with a remaining life expectancy at age 18 of 58 years for men and 63 years for women, the discounted present value of a QALY is approximately 1.7 million Euro, i.e. six to seven times as high of the costs per QALY.

It should be noted that these figures only represent the effects of education on quality of health, and do not quantify the effects of education on mortality. So, it appears that the health benefits of education are much larger than the costs per QALY and that investing in education has a large positive cost-benefit ratio.

4 In a meta-analysis of 33 studies that have calculated the value of a statistical life Mrozek & Taylor (2002) infer that that the value of statistical life is between $ 1.5 million to $ 2.5 million. At a 5% discount rate this would make the value of a statistical life year somewhere between $ 76.500 and $127.500. An estimate of $ 100.000 for a QALY is exactly in the middle of these two estimates.

6. Conclusion

There is overwhelming evidence for a positive relation between education and health. It is difficult to prove, however, that this relation also represents a causal effect. The studies that have tested for endogeneity in the effect of education on health yield mixed conclusions. The theoretical arguments for a causal relation also do not provide the solid foundation one is looking for. For example, Becker & Mulligan (1994) argue that education leads to a lower time preference for consumption in the present and a higher time preference for consumption in the future. Education may change time preferences. However, differences in time preference between higher and lower educated people may also reflect a form of self-selection. People who self-select high levels of education are also likely to postpone other immediate forms of gratification that are frequently damaging to one's health. People with a lower time preference to begin with are more likely to defer consumption and to spend time on investments in human capital that have a pay-off at a later date. Similarly this lower time preference may make that people invest more in health behavior and a healthy life style, refrain from smoking, alcohol abuse, drug taking and other health damaging habits. The association between education and health may then be due to a common causal factor: a lower time preference that makes that one invests more both forms of human capital: education and health. All this does not preclude, however, that education in itself contributes to a lower time preference and that – aside from these common causal factors, education causes people to live healthier.

Our reading of the literature is that the effect of education on health represents a genuine causal effect, that the reverse effect running from health to education is

relatively small (at least for adults), and that there are common factors – most notably time preferences – that affect both investments in health and education.

The available evidence suggests that there is a strong link between education and health. This view is supported by the results of our meta-analysis. The relationship found in the meta-analysis might actually be an underestimate of the real magnitude of the effect. This is because lower levels of education appear to be associated with underreporting of illness by patients (see Mackenbach et. al 1996).

One important aspect that should not be overlooked is the role of intermediate variables in the relation between education and health. One example is that through intermediate variables parental education affects health. Most studies do not find a direct linkage between parental education and health at an adult age if one's own the educational attainment is controlled for. These studies do, however find that one's own education has a positive effect on health and that parental education is an important factor explaining one's own education. So, parental education does have an effect on health through its effect on educational achievements. But that is not all. The findings also suggest that parental education has an effect on birth weight. Birth weight has both a direct and an indirect effect on adult health. Birth weight affects health indirectly through its effect on subsequent educational attainment. So there are several intermediate factors that provide linkages between parental education and health.

Finally, the relation between education and health has important implications for public policy. Public policies tend to be highly compartmentalized: Education is the domain of the Ministry of Education while health care is looked after by the Ministry of Health. What this survey has shown is that there are large spill-over effects between

education and health. This implies that education and health policies do not have an effect within their own domain, but that there are large costs and benefits associated with these policies. This entails that these policies should not be looked upon in isolation, but that rather a more comprehensive or integrated policy approach to education and health is called for.

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Table 1 Indicators on education and health for some selected countries					
Country	*HDI Rank*	*Net primary enrollment ratio*	*Net secondary enrollment ratio*	*Life expectancy at birth 2000-05 (years)*	*Infant mortality rate (per 1000 births)*
Norway	1	101	95	78.9	4
Iceland	2	102	83	79.8	3
Sweden	3	102	96	80.1	3
Australia	4	96	90	79.2	6
Netherlands	5	100	90	78.3	5
Belgium	6	101	..	78.8	5
United States	7	95	88	77.1	7
Canada	8	99	98	79.3	5
Japan	9	101	101	81.6	3
Switzerland	10	99	88	79.1	5
United Kingdom	13	99	94	78.2	6
France	17	100	92	79.0	4
Germany	18	87	88	783	4
South Korea	30	99	91	75.5	5
Argentina	34	107	79	74.2	16
Belarus	53	108	76	70.1	17
Russian Federation	63	..	..	66.8	18
Saudi Arabia	73	58	51	72.3	23
Ukraine	75	72	..	69.7	17
China	104	93	..	71.0	31
Indonesia	112	92	48	66.8	33
India	127	..	..	63.9	67
Ghana	129	58	31	57.9	57
Pakistan	144	66	..	61.0	84
Tanzania	160	47	5	43.3	104
Sierra Leone	175	..	..	34.2	182

Source: UN Human Development Report 2003

Table 2 Characteristics of studies included in the meta-analysis										
Study	Year of data collection	Country	Econometric method	Gender	Age group	Controls for income or parental education	Education	Health outcome	Significant effect of education	Qualy weight
Adams (2002)	1992	United States	OLS	Men and women separately	Between 51 and 61	Parental education	Years	Binary	Yes	0.023 for men and 0.024 for women
Arendt (2004)	1990 and 1995	Denmark	OLS	Men and women separately	All	No	Years	5 point scale	Yes	0.034 for men and 0.029 for women
Benyamini, Leventhal & Leventhal (2004)		United States	OLS	Both	Residents of retirement community	No	1 Dummy	5 point scale	Yes	0.018
Case & Deaton (2003)	1986-2001	United States	Ordered probit	Both and men and women separately	All age 18-60	Income	Years	5 point scale	Yes	?
Cornelisse (2004)	2002	Netherlands	Ordered probit	Both	All including ethnic	No	3 Dummies	5 point scale	Yes	0.017

					minorities					
Denton & Walters (1999)	1994	Canada	OLS	Men and women separately	All aged 20 and older	Income	Years	5 point scale	Yes	0.023 for men and 0.032 for women
Ferrer-I-Carbonel & Van Praag (2002)	1992-1997	Germany	OLS with fixed and random effects	Both	Employed and non-employed workers from East and West Germany	Income	Log years	10 point scale	Yes	0.012 0.018 0.021 0.025
Gerdtham, Johannesson, Lundberg & Isacson (1999)	1995	Sweden	Tobit and Ordered probit	Both	All aged 20-84 years	Income	2 dummy variables	VAS, TTO and 5 point scale	Only for TTO and 5 point scale	0.005 0.009
Groot (2000)	1995	Britain	Ordered probit	Both	All 15 years and older	No	Years	5 point scale compared to own age	Yes	0.013
Groot & Maassen van den Brink (2004a)	1999	Netherlands	Ordered probit	Men and women separately	All 16 years and older	Parental education	Years	5 point scale	Yes	0.006 for men; 0.003 for women
Groot &	1991 and	Britain	Ordered	Men and	All 15	No	Years	5 point	Yes	0.012

Maassen van den Brink (2004b)	1998		probit	women separately	years and older			scale compared to own age		and 0.005 for men; 0.011 and 0.008 for women
Hartog & Oosterbeek (1998)	1995	Netherlands	Ordered probit	Both	People aged 53	IQ, parental education and occupation father	6 Dummy variables	5 point scale	Yes	0.022
Leigh (1998)	1986	United States	Ordered probit	Men and women separately	Household heads and wives aged 30 and older	Earnings and parental education	Years of education	Health scale based on ADL	Yes	0.007 for men and 0.021 for women
McDonough, Walters & Strohschein (2002)	1994	Canada	OLS	Women	Women aged 25-64	Dummies for income	Three dummies for education level	5 point scale	Yes	0.030
Rose (2000)	1998	Russia	OLS	Both	People aged 18 and older	Household income	Nine category variable	5 point scale	No	N.A.
Ross & Mirowsky	1995	United States	OLS	Both	People aged 18	Household income	Years	5 point scale	Yes	0.020

(1999)					and older	and parental education				
Salas (2002)	1995	Britain	Ordered probit	Men and women separately	People aged 60 and older	No	1 dummy variable for vocational or academic college	5 point scale compared to own age	Yes	0.015 for men and 0.021 for women
Szaflarski & Cubbins (2004)	1994	Poland and United States	OLS	Both	People 18 years and older	Family income	Years	4 point scale	Yes	0.026 in Poland and 0.048 in US
Shmueli (2003)	1993	Israel	OLS	Both	All aged 45-75	Dummy for economic status	Years	VAS	Yes	0.007

Notes: Adams (2002) uses three different binary dependent variables (good/better, very good/better and excellent/better). We use the findings for excellent or better. QALY weight in study of Benyamini et. al. (2004) is calculated under the assumption that respondents with more than a full high school education have on average an additional four years of education. QALY weight for Cornelisse (2004) is calculated under the assumption that the differences in years of education between lowest and highest education level is eight years. QALY weight for Ferrer-I-Carbonell & Van Praag (2002) are calculated at 11 years of education. QALY weight in study of Gerdtham et. al (1999) is based on dummy variables for university education (10 years of education compared to less than high school). QALY weight in Hartog & Oosterbeek (1998) is calculated for dummy variable for university education (11 years of education after primary school). Calculations are based on additional information obtained from the second author. In Leigh the parameter estimate for the years of education variable for women is –0.0587, as the value in the table has a typing error. QALY weight in McDonough, Walters & Strohschein (2002) is calculated using coefficient for secondary school diploma

under the assumption that it takes 4 years to complete a post-secondary degree/diploma. QALY weight in Salas (2002) is calculated on the assumption that a vocational or academic college – on average - requires 6 years additional education.

Table 3 Means and OLS regression estimates QALY weights meta-analysis (standard errors in brackets)			
	Mean QALY weight	*Random effect regression estimates QALY weights*	
		All variables	*Variables with t-value > 1*
Total sample	0.018 (0.010)		
Intercept		1.089 (0.640)	0.023** (0.004)
Year of data collection			
Year		-0.001 (0.000)	
Country			
European or Canada	0.015 (0.008)		
United States	0.025 (0.011)	0.015** (0.003)	0.008* (0.004)
Econometric method			
OLS	0.024 (0.009)		
Ordered probit	0.012 (0.006)	-0.010* (0.005)	-0.009* (0.004)
Gender			
Male	0.016 (0.010)	-0.003* (0.001)	
Female	0.020 (0.010)	-0.007 (0.005)	
Both	0.019 (0.011)		
Age group			
All	0.017 (0.012)		
Aged 60 and older	0.015 (0.006)	-0.004 (0.006)	
Younger than 60	0.022 (0.005)	-0.003 (0.005)	
Controls for income or parental education			
No	0.017 (0.009)		
Yes	0.019 (0.011)	-0.014** (0.005)	-0.004 (0.004)
Specification of education variable			
Years of education	0.019 (0.011)		
Dummy variable(s)	0.017 (0.008)	0.007 (0.005)	
Health outcome			
Otherwise	0.020 (0.011)		
Compared to others	0.012 (0.005)	-0.003 (0.007)	
Number of Observations		30	31
Adj-R2		0.401	0.391
Inter study correlation		0.066	0.167
Hausman specification test		0.449	4.565*
LM heteroskedasticity test		2.448	2.817

* significant at 5% level; ** significant at 1% level