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## The impact of health and health behaviours on educational outcomes in high-income countries: a review of the evidence



**Marc Suhrcke,**

School of Medicine, Health Policy and Practice,  
University of East Anglia, United Kingdom

**Carmen de Paz Nieves,**

Fundación Ideas, Madrid, Spain





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Fundación Ideas, Madrid, Spain

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Marc Suhrcke, School of Medicine, Health Policy and Practice, University of East Anglia, United Kingdom  
Carmen de Paz Nieves, Fundación Ideas, Madrid, Spain

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## Abbreviations

ADHD	attention deficit hyperactivity disorder
ANOVA	analysis of variance
BMI	body mass index
CE	coordinative exercise
ESS	Epworth Sleepiness Scale
ETS	environmental tobacco smoke
GATOR	Georgetown Adolescent Tobacco Research
GEE	generalized estimating equation
GPA	grade point average
HI	hyperactivity-impulsivity
MAP	Missouri Assessment Program
MLDA	minimum legal drinking age
NBER	National Bureau of Economic Research
NHANES III	Third National Health and Nutrition Examination Survey
NLSCY	Canadian National Longitudinal Survey of Children and Youth
NLSY	National Longitudinal Surveys of Youth (United States of America)
NLSY79	1979 National Longitudinal Surveys of Youth (United States)
NTDS	National Public School-Head Start Transition Demonstration Study
NSL	normal sports lesson
OECD	Organisation for Economic Co-operation and Development
OEO	Office of Equal Opportunity (United States)
PDSS	paediatric daytime sleepiness scale
PIAT	Peabody Individual Achievement Test
PIATR	Peabody Individual Achievement Test–Revised
PPVT-R	Peabody Picture Vocabulary Test–Revised
PSID	Panel Survey of Income Dynamics
PUMS	Public-Use Microdata Sample
SOEP	German Socioeconomic Panel
TSIV	Two-Sample Instrumental Variables
WIC	Special Supplement Nutrition Program for Women, Infants, and Children (United States)
WISC-III	Weschler Intelligence Scale for Children–III

## Executive summary

While the importance of education is widely appreciated as a public policy priority in industrialized countries and cross-country comparative rankings of educational performance typically provoke major national debates, comparably little attention, outside of health, is paid to the impact of child and adolescent health on education. Part of the reason could be the perception that child health is but a by-product of education rather than a factor that could determine educational outcomes. This report casts doubt on this perception by critically examining the evidence on the effect of health on education in industrialized countries.

Based on seemingly underrecognized evidence, our overall finding is that there is reason to believe health does have an impact on education. This finding should serve as a basis for raising the profile of child health in the public policy debate, and by illustrating the potential for mutual gains, it should help stimulate cross-sectoral collaboration between the health and education sectors.

Education and health are known to be highly correlated – that is, more education indicates better health and vice versa – but the actual mechanisms driving this correlation are unknown. The effect of health on education has been well researched in developing countries, as has the effect of education on health in both developing and industrialized countries. Such imbalance could signal lack of attention not only in research but also in the public policy debate. While children in developing countries face more serious health challenges than those in industrialized ones, the potentially relevant effect of health on their educations (and perhaps on labour force participation) cannot be ruled out.

The analytical framework we used to guide our research posits a path leading from health behaviours (e.g. smoking) and health conditions (e.g. asthma) to educational attainment (level of education) and educational performance (e.g. grades). We searched literature in the fields of health, socioeconomic research, and education and ultimately narrowed our selected publications to 53, all of them based in countries belonging to the Organisation for Economic Co-operation and Development.

Based on the evidence reviewed, some of our more important findings are the following.

- Overall child health status positively affects educational performance and attainment. For example, one study found that very good or better health in childhood was linked to a third of a year more in school; another concluded that the probability of sickness significantly affected academic success: sickness before age 21 decreased education on average by 1.4 years.
- The evidence indicates that the negative effect on educational outcomes of smoking or poor nutrition is greater than that of alcohol consumption or drug use.
- Initial research has found a significant positive impact of physical exercise on academic performance.
- Obesity and overweight are associated negatively with educational outcomes.
- Sleeping disorders can hinder academic performance.
- Particularly underresearched, especially considering their growing significance, is the effect of anxiety and depression on educational outcomes.
- Asthma on average has not been shown to affect school performance.
- The preponderance of research was based in the United States of America, but overall this field has grown markedly since 2001, including in Europe.
- From a methodological perspective it is important to note that several papers undertake serious efforts to tackle the challenge of proving causality in the relationship.

In light of the comparative lack of European evidence, there is a genuine need to undertake further targeted research in this somewhat neglected area. Nevertheless, the evidence that already exists should be actively disseminated across both education and health ministries and agencies.

Academics and practitioners should be encouraged to share the wide range of evidence sources they have; doing so may contribute to a greater understanding of this area of work. This evidence should include recognition of the value of qualitative evidence and grey literature.



# 1. Introduction

The relationship between health and education is doubtless a close one. In particular, the public health literature has widely documented the correlation between these two dimensions of human capital in both developing and industrialized countries. More often than not, this association is interpreted or even shown to represent, especially in industrialized countries, a causal effect running from education to health: a better education leads to better health. This publication explores, specifically in high-income countries, the extent to which a causal link may also run the other way, from health to education. That is, does better health lead to a better education? We start with the hypothesis that this direction of the relationship has been somewhat ignored both in research and, arguably, in the public policy debate. To date, far more attention has been paid to the importance of health for education in the research on developing countries, documenting in particular very clearly the importance of child and adolescent health for educational attainment and performance. While there is obvious reason to believe that the health challenges children face in rich countries affect education to a lesser extent than the more life-threatening health challenges in poor countries, a potentially relevant effect of health on education in the industrialized world cannot be automatically ruled out.

This study aims to systematically review the current knowledge of the effect that different health conditions and unhealthy behaviours can have on educational outcomes in the context of rich countries. Specifically, we examine research on the following questions.

- Does poor health during childhood or adolescence have a significant impact on educational achievement or performance?
- Does the engagement of children and adolescents in unhealthy behaviours determine their educational attainment and academic performance?

As it turns out, although these questions have not been a major research focus, the evidence that does exist offers a lot to suggest a causal contribution of health to various educational outcomes. While gaps in the research do remain, its results already bear relevant policy implications both for the wider importance of child health in rich countries (extending beyond the health benefits *per se*) and for the ways in which educational outcomes might be improved.

The publication is structured as follows. In section 2 we review briefly some of the evidence and hypotheses behind the linkage between health and education in general. Section 3 presents a conceptual framework to organize the different ways in which health may impact education. Section 4 describes the literature search methodology. Section 5 presents the core results of the literature review, first in terms of basic summary statistics and second in a more detailed, synthesis format. The final section draws together our conclusions.

## 2. The association between education and health

A fairly large body of evidence both in the economics and public health literature documents a positive correlation between health and education. Due to the empirical challenges involved in assessing causality in the relationship, there is less agreement on what the precise mechanisms are that drive this correlation. As first highlighted by Grossman (1973) and more recently by other authors including Cutler and Lleras-Muney (2006); Ding et al. (2006); Gan and Gong (2007), health and education may interact in three not mutually exclusive ways:

- 1) education may determine health;
- 2) one or more other factors may determine both health and education simultaneously; and
- 3) health may determine education.

Education may determine health. The predominant view appears to be that the effect of education on health is primarily driving the correlation in high-income countries. A set of quasi-experimental studies across different countries confirmed this view and was summarized, for instance, by Cutler and Lleras-Muney (2006). Similarly, a recent study by Lundborg (2008), using data on identical twins to estimate the health returns to education, concluded that higher educational levels positively affect self-reported health and reduce the number of chronic conditions.

The link between education and health has different potential explanations. First, education as a long-term investment provides an incentive to individuals to stay healthy and reap the benefits of such investment. Cutler and Lleras-Muney (2006) in this regard highlight differences in preferences and an individual's valuation of his or her future that may both be affected by the level of education as relevant factors explaining health outcomes. Second, as a key "input" in the health production function, education may also help individuals maintain or improve their health, mostly by means of their enhanced knowledge of health issues, information availability and cognitive skills (Grossman, 1973; Cutler and Lleras-Muney, 2006). Finally, educational achievement is correlated with higher earnings through access to better job opportunities and social networks, which in the long term is expected to translate into higher health expenditure and thus better health (Grossman, 1975; Kenkel, 1991; Rosenzweig and Schultz, 1991 as cited in Gan and Gong, 2007; Lleras-Muney, 2006).

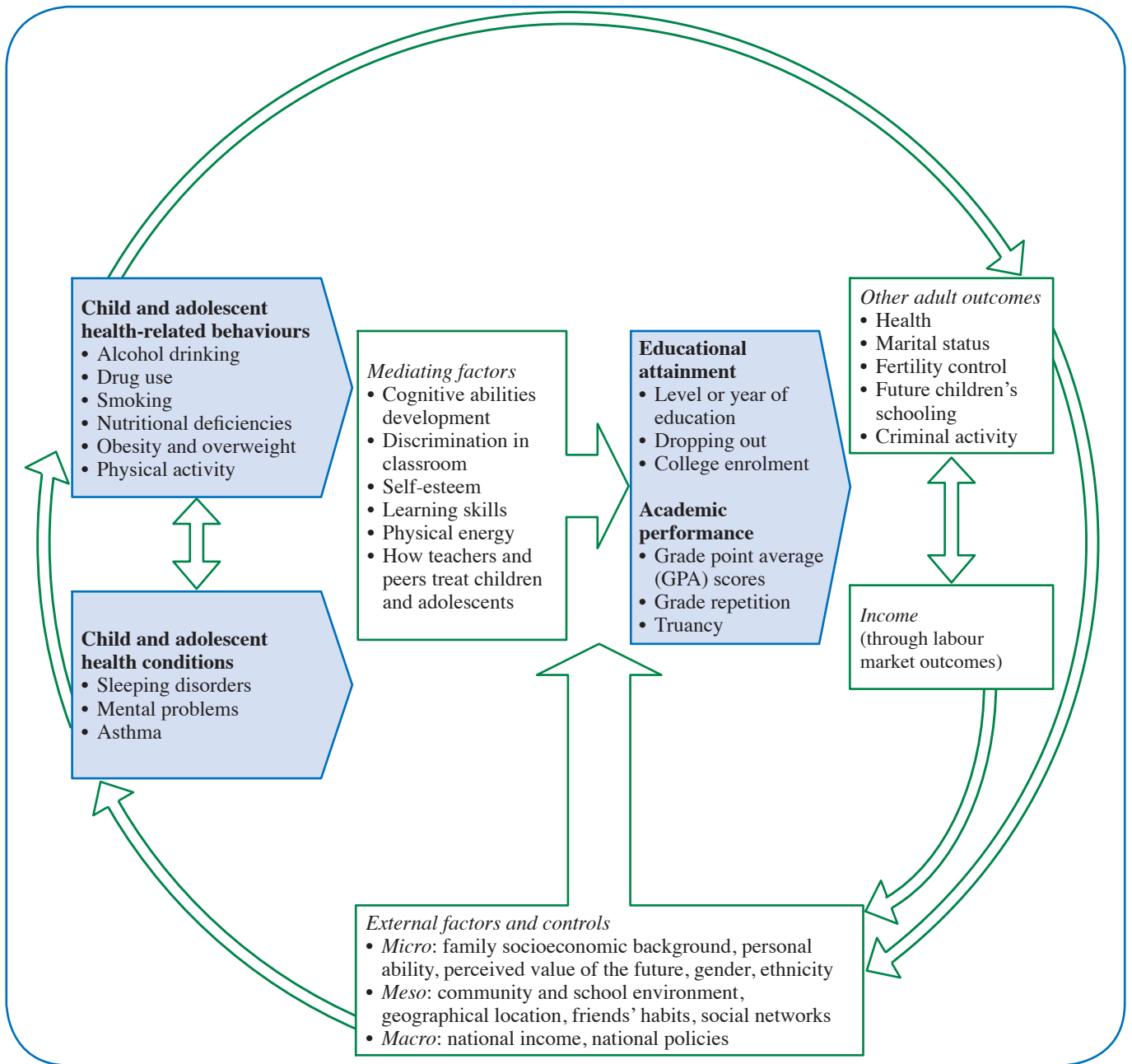
One or more other factors may determine both health and education simultaneously. Some researchers suggest that it is mostly external factors that simultaneously affect both education and health. For instance, Case, Fertig and Paxson (2005), using panel data from the United Kingdom, found that children's health was significantly affected by the socioeconomic status of their family. Currie et al. (2004) concluded similarly that around 60% of the variation in children's health in a sample of English siblings was explained by "unobserved" family characteristics, i.e. not investments in health or education. In line with these findings from the United Kingdom, Smith (2008) concluded on the basis of a sample in the United States that significant differences existed in the estimated impact of health outcomes on education between regular and within-sibling models, reinforcing the hypothesis that family background likely plays a key role in both children's health and education.

Health may determine education. Last but not least and in accordance with the prime focus of this study, health may also be a determinant of educational outcomes (Gan and Gong, 2007). Of the three potential mechanisms this one appears to be the least researched in high-income countries. The subsequent section describes in more detail the potential mechanisms that might explain such a causal impact. Parts of the relevant literature in this field were recently reviewed by Currie (2008) and Taras and Potts-Datema (2005 a, b, c and d). Our review builds on these efforts and complements them in various ways. Currie's (2008) excellent review did not comprehensively cover all the available literature on the topic. Neither her nor the Taras and Potts-Datema (2005 a, b, c, and d) reviews exhaustively covered the evidence on the impact of different health behaviours on educational outcomes. In addition, since Taras and Potts-Datema's reviews were published in 2005, they could not capture the notably growing research output – albeit from a low base – in more recent years. To the best of our knowledge, this is the first effort to comprehensively study the effect of health behaviours and health conditions on educational outcomes within a common analytical framework.

### 3. From health to education: a conceptual framework

This section presents the framework we use to conceptualize the causal association between health and education (see Fig. 1 for a graphical illustration).

**Fig. 1. Analytical framework of the causal association between health and education**



#### Health outcomes and conditions

The two boxes on the left of the diagram represent the main explanatory variables in the model, i.e. children and adolescents' health indicators, which we classify into health conditions and health behaviours (or "risk factors"). In our review we took into account the following health-related behaviours:

- alcohol drinking
- drug use

- smoking
- nutritional deficiencies
- obesity and overweight
- physical activity.

The health conditions we systematically studied in this review included:

- sleeping disorders
- mental health and well-being (comprising anxiety and depression)
- asthma.

These health conditions and risk factors tend to coincide with and affect each other, as indicated by the double-headed arrow connecting the left-hand boxes. One study illustrated this clearly: studying adolescents in the United States, Ding et al. (2006) found striking differences in the estimated impacts of depression and obesity when examining a single health state in isolation. That research also concluded that individuals with health disorders such as obesity or depression were significantly more likely to smoke. Confirming these findings, students reporting higher levels of sleepiness during the day tended to also report more frequent illness (Drake et al., 2003), and several studies reviewed here highlight a relevant association between nutritional deficiencies and mental health problems (Alaimo, Olson and Frongillo, 2001; Datar and Sturm, 2006). Students who binge drank were more likely than both non-drinkers and drinkers who did not binge to report involvement in other risky health behaviours according to Cutler, Miller and Norton (2007). In addition, Ellickson et al. (2004) found that early smokers were at least three times more likely by grade 12 than non-smokers to regularly use marijuana and hard drugs. Sleepiness has also been associated with a higher incidence of anxiety and behavioural problems (Gibson et al., 2006). Therefore, in assessing the impact of health behaviours on education, it is important to avoid considering the health behaviours and/or health conditions in isolation of each other.

## Mediating factors and educational outcomes

The focus of this review and the main question to be addressed within the framework is the extent to which the selected risk factors and health conditions have a significant effect on educational outcomes. This core link is highlighted in the central, blue-background box in the figure.

However, health can influence education not only directly but also through the mediating mechanisms listed in the “mediating factors” box in the diagram. Guo and Harris (2000), for instance, demonstrated that cognitive stimulation is one of the main mechanisms through which poverty affects children’s intellectual development and thus school achievement. Mediating factors include all those aspects determined by health that in turn can have an impact on educational outcomes e.g. (Ding et al., 2006):

- cognitive and learning skills development
- treatment received by children in the classroom in connection with their health condition(s)
- discrimination by peers
- self-esteem
- students’ physical energy.

Educational outcomes are classified for the purpose of this review into longer and shorter term indicators. The long-term outcome considered is educational attainment, proxied by:

- level or years of education achieved
- dropping out
- college enrolment.

Academic performance is the shorter term educational indicator, measured by:

- GPA or grades
- grade repetition
- days of class missed or skipped (truancy).

Although most articles included here analyse the direct relationship between health conditions and behaviours and educational outcomes, some go a step further and attempt to assess this relationship through the impact of certain policies and programmes related to different health aspects on education.

## External or control factors affecting both health and education

As highlighted in the previous section, both health and education outcomes of children and adolescents can be determined by a set of external or “third” factors, represented in the box at the bottom of the diagram. The presence of both observable and (in particular) unobservable common determinants of health and education tends to complicate the empirical estimation of the relationship between health and education, as discussed in subsequent sections. Aspects such as family background and individual characteristics of children (e.g. preferences) play an important role in shaping the relationship between health and education. Hence failure to take those often hard to observe factors into account would seriously bias any coefficients on the health variable.

Most studies try to mitigate this problem by controlling for as many additional and relevant observable variables as possible through multivariate regression analysis. However, this effort in itself is mostly not sufficient to entirely rule out the influence of unobservable characteristics. Other studies attempt to control for unobservable factors that do not vary over time or within a family, e.g. through the use of siblings and/or twins data (“fixed-effects models”). Still others attempt to overcome endogeneity problems through the use of alternative methodologies such as instrumental variables, difference-in-differences, matching estimates and discontinuity design.

The external factors that published studies have considered (or have suggested as important) in their analyses of the relationship between health and education may operate at the micro, meso and macro levels. At the micro level some of the main determinant factors include (Cutler and Lleras Muney 2006; Fuchs 1982; Smith, 2008; Currie, 2008):

- family socioeconomic status
- ethnic factors
- gender
- order among siblings
- value associated with the future or discount rate
- personal (“innate”) ability.

Smith (2008), for instance, emphasized the possibility of large biases from unobserved family effects in studies assessing the potential interdependence between health and education. Other research has illustrated the gender difference in the impact of obesity (Cawley and Spiess, 2008) or mental health (Fletcher, 2008) on educational outcomes.

Factors that can determine children’s and adolescents’ development at the meso level include (Klingeman, 2003):

- community, neighbourhood and school characteristics
- access to information and social networks
- friends’ habits.

Pate et al. (2006) demonstrated the importance of girls’ living environments to their physical activity. Other meso factors seem to be particularly relevant in the development of health-related behaviours: Duarte, Escarioa and Molina (2006), for instance, found that individual marijuana use was positively correlated with adolescents’ nightlife and friends’ smoking habits, but inversely related to school information campaigns.

Finally, the macro-level policy framework may also affect both health and education. Cross-country or cross-regional

variation in health- and/or education-related policies and programmes can provide natural experiments that help us more reliably identify the causal pathways between health and education. Studying data from the United States, where minimum legal drinking ages varied over time, Dee and Evans (1997) used an instrumental variable approach to exploit within-state variations in alcohol availability to estimate the impact of drinking on education. Ludwig and Miller (2006) used a discontinuity in the funding of the United States Head Start (early education) programme providing schooling and health support to poor counties to find a parallel discontinuity in educational attainment among participants.

## Impact of health on future prospects through education and intergenerational transmission of inequalities

Taken together, children's education, health and third factors account for differences in employment status and income when they become adults, as well as their adult health outcomes, marital status, fertility control and engagement in criminal activities and in the educational achievement of their own children. Using within-sibling models on panel data in the United States, Smith (2008) found that good health during childhood increased adult family incomes by 24%, when compared to poor health.<sup>1</sup> Case, Fertig and Paxson (2005) also support the main hypothesis of life-course models that childhood health conditions have a lasting impact on health and socioeconomic status in middle adulthood. According to these authors, health at ages 23 and 33 was a significant predictor of health at age 42, as were indicators of socioeconomic status at the younger ages.

These adult outcomes in turn are likely to influence the health conditions and behaviours of the next generation, which would affect educational outcomes and overall future prospects in a self-reinforcing cycle. Health differences affecting the intergenerational transmission of poverty through educational outcomes may therefore explain a significant share of the existing socioeconomic inequalities in developing but also in industrial countries (Currie, 2008). Currie and Stabile (2007) specifically suggest that variations in the incidence of health insults during childhood may be important in explaining the gap in the long-term health status between rich and poor. The inter-generational transmission of health is represented by the connection through the external factors and controls at the bottom of the diagram between the boxes representing adult outcomes at the right-hand side of the diagram and, on the left, child and adolescent health behaviours and conditions.

The above, conceptual inter-linkages by themselves pose important challenges for any empirical test of the conceptual model, in particular for the assessment of the true causal impact of health on education. There are at least three major difficulties in estimating the contribution of individual health to educational outcomes: reverse causality, omitted variable bias and measurement error. If a standard single equation regression is applied, those problems can lead to biased estimates of the coefficient of the health variable (and of the other independent variables), because they lead to the error term being correlated with the health variable, a feature known as “endogeneity” of the health variable. As discussed below, several studies explicitly recognized this challenge and adopted econometric techniques that can at least in principle help reduce or eliminate the otherwise resulting bias.

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<sup>1</sup> The health measure in Smith (2008) is based on a five-point scale, including the categories poor, fair, good, very good and excellent. The last two categories were defined as “good health” and all other categories taken together as “poor health”.

## 4. Search methodology

Online databases were the primary source of the reviewed literature. The search was conducted in three main thematic areas: health and public health, socioeconomic studies and research, and education.

1. Under the category of health and public health we used both general online databases, such as ScienceDirect, InterScience and Scirus, and health-specific databases, mainly PubMed, BioMed and Cochrane. A further online search of all issues between 2005 and 2008 was conducted to ensure exhaustiveness in the case of specific online journals, i.e. the *American Journal of Public Health*, *Journal of Health Economics*, *Journal of School Health* and *The Journal of Pediatrics*.
2. For socioeconomic studies and research, IngentaConnect, RePec, JSTOR, Palgrave, SagePub, SpringerLink and ISI were the most important databases. Other specific online resources included the National Bureau of Economic Research (NBER) database and the *Journal of Health Economics*.
3. For education, we conducted an exhaustive online search of the *British Journal of Educational Psychology* and the *Economics of Education Review*.

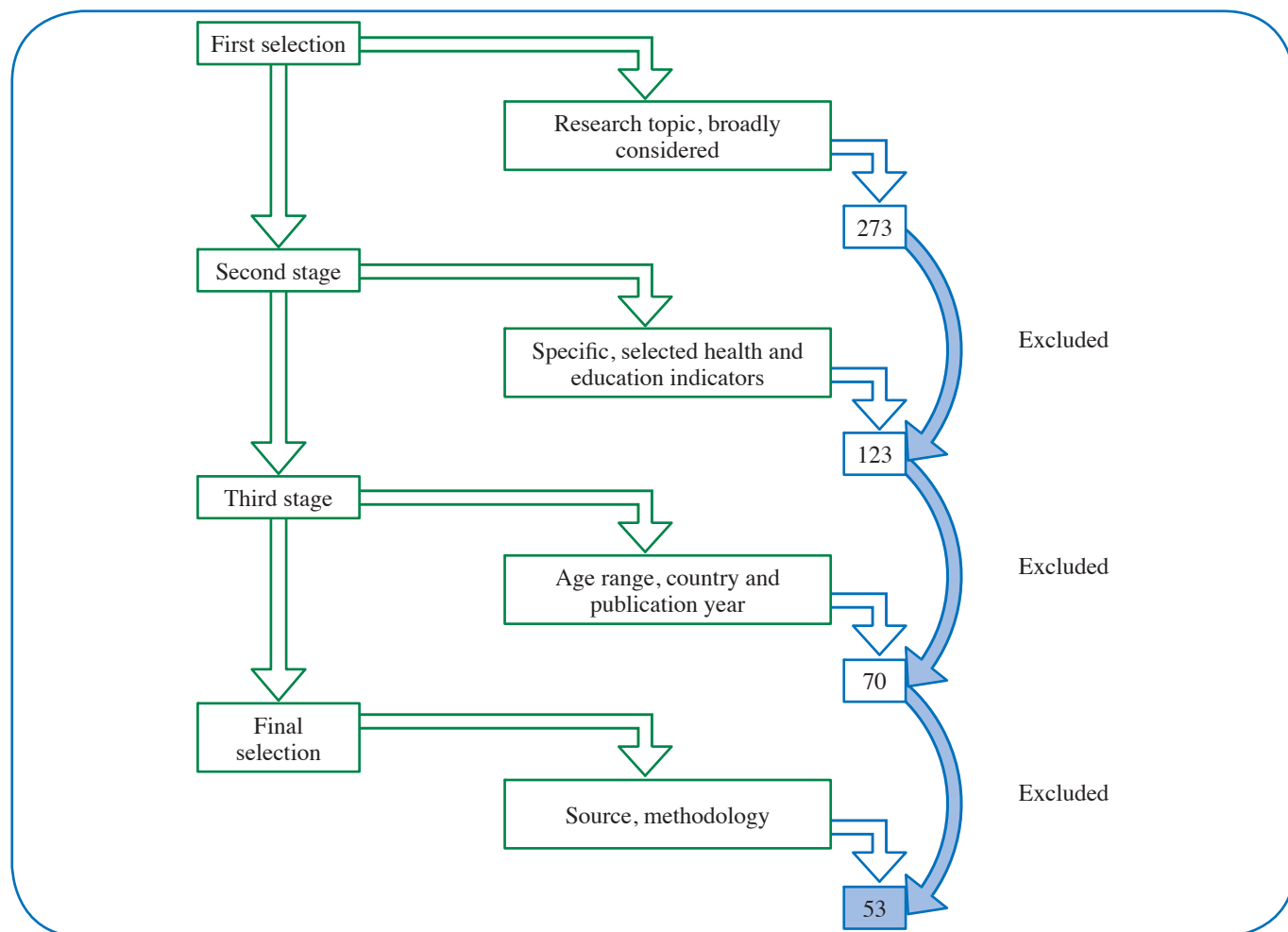
The essential search criteria for the main databases used are detailed in Annex 1.

A recent literature review by Currie (2008) and four reviews by Taras and Pott-Datemas (2005a, b, c and d) provide a comprehensive, initial picture mainly concerning specific chronic conditions such as sleeping disorders, mental health problems, asthma and some health-related behaviours, including deficient nutrition, obesity and physical exercise. Other relevant reviews used included that of Murray et al. (2008) on the literature assessing the impact of school health programmes on academic achievement, Cueto (2001) reviewing the effect of breakfast programmes on educational outcomes and Trudeau and Shephard (2008) on the relationship between physical education and physical activity and academic performance. While the main conclusions of those reviews have been considered and are indeed referred to frequently throughout this study, we did not review the original literature covered in those previous reviews.

We adopted the so-called “snowballing” process in our search. Relevant references in the most significant papers were searched and, when appropriate, included in the review, and in every database we always searched readings related to those that were pre-selected, typically yielding relevant results.

We initially selected 273 articles on the basis of the research topic, broadly considered. The selection was narrowed to 123 using the specific relevant indicators (discussed in the subsequent section) as the main inclusion criteria. The search was further restricted to 70 based on the age range of the study subjects, the country and the publication year. All papers were stored in an Endnote database, and in the process their abstracts and in most cases the entire paper were screened and a final selection on the basis of the source and methodology used was carried out. In the end, 53 papers remained (Fig. 2).

**Fig. 2. Study selection criteria and process**





## 5. Results of the literature review

In this core section of the publication, we present the findings of our review, first at a very generic, descriptive level and subsequently in a more detailed, analytical format.

### Selected summary statistics

The most basic characteristics according to which the papers reviewed can be disaggregated in a fairly simple manner are as follows: health and education indicators used; publication date; country of study; age range of study subjects; source; methodology; and qualitative result of the research.

#### *Health and education indicators*

The focus of the review and therefore of the literature search was the impact of health behaviours and health conditions on educational outcomes. Table 1 shows that most reviewed papers (n=30) explored the connections between alcohol drinking, marijuana use, smoking, nutrition and physical exercise, and educational outcomes. Evidence was particularly profuse in the case of alcohol drinking (n=9) and marijuana use (n=7) compared to the other health-related behaviours. A total of 23 papers studied the effect of three health conditions—sleeping disorders, anxiety and depression, and asthma—on education as well as the impact of overall health on educational outcomes. The numbers in Table 1 do not imply that there has necessarily been less research on health conditions than health behaviours. Taras and Potts-Datema (2005 a, b, c and d) and Currie (2008) have already included in their review a considerable number of studies, and to avoid duplication we excluded those studies from our review.

**Table 1. Number of papers reviewed, by health behaviours and conditions**

<b>Health risk factors</b>	<b>30</b>
Alcohol drinking	9
Marijuana use	7
Smoking	4
Nutritional problems and obesity	6
Physical exercise	4
<b>Health conditions</b>	<b>23</b>
Sleeping disorders	5
Mental health problems	6
Respiratory problems	4
Overall health	8
<b>TOTAL</b>	<b>53</b>

Table 2 shows the distribution of the studies by outcome variable considered. Most studied the relationship between different health indicators and academic performance, mainly measured through scores, both self-reported and actual. Only 12 of the 53 papers looked at the effect of health on what we call mediating factors, typically cognitive skills development, as measured, for instance, through the Peabody Individual Achievement Test (PIAT).<sup>2</sup>

<sup>2</sup>PIAT is an individually administered measure of academic achievement that is norm-referenced. Designed to provide a wide-range screening measure in five content areas that can be used with students in kindergarten through 12th grade, its content areas are mathematics, reading recognition, reading comprehension, spelling and general information.

**Table 2. Number of papers reviewed, by educational outcome**

<b>Educational attainment</b>	<b>22</b>
School readiness	1
High school dropout	5
High school completion	6
Years of education achieved	4
Level of education achieved	6
<b>Academic performance</b>	<b>35</b>
Scores	15
Self-reported performance	7
Grade repetition	5
Missed days, truancy	8
<b>Mediating factors</b>	<b>12</b>

*Note:* Total exceeds 53 because some papers reported more than one educational outcome.

### *Date of publication*

We considered only studies published between 1 January 1995, and 30 June 2008. Sophisticated econometric analysis of the relationship between the factors of interest was barely conducted before the 1990s, and its relevance today would be questionable if only due to changes in perceptions, habits and health and educational standards in the countries studied. Over two thirds of the papers we reviewed were conducted after 2001, further indicating a recent upsurge in the academic interest in this topic (see Table 3).

**Table 3. Number of papers reviewed, by year of publication**

1 January 1995 – 31 December 2001	12
1 January 2002 – 30 June 2008	41
<b>TOTAL</b>	<b>53</b>

### *The country of study*

Only literature on countries in the Organisation for Economic Co-operation and Development (OECD) was reviewed. As highlighted in the introduction, the relevance and implications of the relationship between health and education are likely to differ between developing and high-income contexts. The role of health in determining educational outcomes has been more extensively studied in developing countries, while remaining comparatively scarce in high-income countries.

As seen in Table 4, most of the studies focus on the United States and make use of their datasets (40 of 53), indicating a clear gap in research on the topic in European and other OECD countries. The most common data sources are longitudinal or panel data from official surveys, such as the National Longitudinal Survey of Youth (NLSY), the National Youth Risk Behaviour Survey and the United States Third National Health and Nutrition Examination Survey. Additionally, narrower samples and data from small natural and randomized experiments are used.

### *Age range of study subjects*

The ages of the sample of children and adolescents studied were to be between 1 and 18 years. Literature on pre-natal health factors and their impact on child development (see e.g. Currie, 2008), although profuse, was excluded from this review mainly due to the rather different set of policy implications it relates to.

**Table 4. Number of papers reviewed, by country**

United States	40
Europe	9
Germany	3
Italy	1
Spain	2
United Kingdom	3
Others	4
TOTAL	53

### *Empirical methodology*

We gave priority to studies that performed some form of more advanced econometric analysis, by which we mean the application of at least single equation multivariate regression analysis. As Table 5 indicates, the majority of studies used this methodology, implying that most studies did not undertake specific efforts to overcome the endogeneity problem mentioned above.<sup>3</sup> A significant minority undertook efforts to correct for endogeneity issues, mainly by using quasi-experimental techniques and in rare occasions through randomized experimental design of the study. While not visible in Table 5, we did note a trend towards the increased use of more sophisticated approaches in attempts to adjust for endogeneity, such as via instrumental variables, fixed effects, difference-in-differences, matching and discontinuity design.

**Table 5. Number of papers reviewed, by methodology**

Single-equation multivariate analysis	26
Instrumental variables	8
Fixed effects	6
Matching estimates	1
Discontinuity design	1
Difference-in-differences	1
Other	12

*Note:* Total exceeds 53 because some studies used more than one analytic method.

### *Source*

The selected readings were mostly journal articles, all peer-reviewed. We did however take into account specific working paper series that meet certain quality criteria, mostly NBER working papers. The decision to include these papers was driven by the impression that in most recent years there has been a growing interest in this field of research, the insights of which would be missed if we limited ourselves to journal articles. The journal versus working paper ratio is in Table 6.

While it can sometimes be hard to unambiguously attribute a given journal to a specific subject, most of the journals in which the articles appeared were health related, although a significant number came from economic sources, including the NBER working papers (see Table 7).

<sup>3</sup> That said, there are of course cases in which a single equation multivariate regression is sufficient to assess causality but this cannot be assumed as given and would need to be tested.

**Table 6. Number of papers reviewed, by journal article versus working paper**

Journal	43
Working papers and discussion papers	10
TOTAL	53

**Table 7. Number of papers reviewed, by field**

Health	32
Economics	20
Education	3
Policy	3
Sociology	2
Demography	2

*Note:* Total number of reviewed papers by field exceeds 53 because some sources address more than one field.

### *Qualitative findings*

All relevant evidence on the relationship between health and education outcomes was to be examined in the review. However, the existing research overwhelmingly suggests, as shown in Table 8, that health conditions and risk factors are significantly and negatively correlated with educational achievement and academic performance, while physical exercise appears to be positively correlated with educational outcomes. At least on the face of it, this is a rather impressive result, even with the caveat that most empirical research may bear a bias in published work.

**Table 8. Number of papers reviewed, by findings**

Significant impact	49
No significant impact	4
TOTAL	53

### **Impact of health-related behaviours and risk factors on educational outcomes: detailed findings**

Underage drinking, increasing marijuana use since the 1990s, smoking and obesity are some of the key public health concerns in high-income countries (Chatterji, 2006; Miller, 2007; Yolton et al., 2005, Datar and Sturm, 2006). Despite the general association between these risky behaviours during childhood and adolescence and poorer long-term developmental outcomes, it is only recently that researchers have attempted to accurately estimate this effect, particularly with regard to education. To the best of our knowledge, this is the first systematic review conducted to date of the literature assessing the impact of these health-related behaviours on educational outcomes.

Potential endogeneity issues, sample representativeness and measurement problems account for the main difficulties faced in estimating the causal impact of health-related behaviours on education. As mentioned in the description of the framework, all these health risk factors are often correlated between them, plus there may be a third set of unobservable factors that influence both education and health. Recent research attempts to overcome these confounding problems using panel data and methodological techniques such as instrumental variables. While the need remains for further research that allows establishing causality with certainty, the existing literature does provide a fair amount of good-quality evidence with relevant policy implications. Overall, there is an additional need to further explore these linkages in OECD countries other than the United States, since such research is lacking in the former.

The studies we reviewed sometimes led to inconsistent conclusions, but some general conclusions are as follows.

- Binge drinking<sup>4</sup> seems to have a significant negative effect on educational attainment, although some studies conclude it is likely to be small. In the case of academic performance, causality is less unambiguous, although all studies investigating this risk behaviour indicate that a significant negative impact exists.
- Marijuana use shows a significant negative impact on educational attainment and academic performance according to all available evidence.
- Smoking is a strong predictor of educational underperformance. Relevant evidence remains limited and faces methodological problems that demand caution in the interpretation of results.
- Evidence on the association between nutritional issues and school success is particularly scarce in industrialized countries, although existing research indicates that a relevant connection likely exists between these factors.
- Obesity and overweight are negatively associated with educational outcomes, although evidence is contradictory concerning the gender-differentiated effect of these risk factors, and endogeneity issues also persist as obstacles in the estimation of causality.
- Recent and limited research indicates that physical exercise might have a positive impact on short-term aspects related to academic achievement, although causality remains particularly difficult to assess.

We now describe the reviewed studies in order of health behaviours and then health conditions. After a textual description of the studies for each behaviour or condition, we provide a table with more systematic detail of each study.

### *Alcohol drinking*

The available empirical evidence on the impact of alcohol drinking on educational attainment offers mixed results. On the one hand, the studies by Dee and Evans (1997) and Koch and Ribar (2001), using instrumental variables and family fixed-effects models on samples from the United States, suggest that the actual effect of alcohol use is likely to be small and sensitive to the model specification. On the other hand, findings by Yamada, Kendix and Yamada (1996), also in a sample of students in the United States, indicate that frequent drinking significantly reduced the probability of high school graduation, in line with Renna's (2004) results indicating that alcohol policies affect the probability that students in the United States graduate on time. This hypothesis was further confirmed by Chatterji and DeSimone (2005), whose instrumental variable regression indicates that binge or frequent drinking among 15–16-year-old students lowered the probability of having graduated from or being enrolled in high school four years later by at least 11%.

With regard to academic performance, the studies by Lopez-Frias (2001), DeSimone and Wolaver (2005) and Miller et al. (2007) unanimously conclude that frequent and binge drinking can have a significant impact on GPA scores or grades. These last two studies in this sense found, using data from the United States, that students who binge drank were more likely to self-report and actually achieve poorer school performance. Causality, however, cannot be established very confidently in these studies.

Except for Lopez-Frias (2001), all the studies reviewed made use of datasets from the United States. The link between alcohol use and education needs thus to be further explored, particularly in the European context, where the minimum drinking age tends to be lower than in the United States and where young people's perceptions and habits among youth likely differ from their counterparts in other OECD countries.

The seemingly robust finding of a harmful impact of alcohol consumption on educational performance complements in interesting ways the rather mixed findings concerning the effect of alcohol consumption on certain adult labour supply and productivity indicators. Several authors have found a counter-intuitive, positive impact of alcohol consumption on such economic outcomes among adults (French and Zarkin, 1995; Hamilton and Hamilton, 1997; Zarkin et al., 1998; MacDonald and Shields, 2001). Peters and Stringham (2006) showed that drinking led to higher earnings by increasing social capital through the strengthening and widening of social networks. These

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<sup>4</sup>Binge drinking is typically defined as consuming five or more drinks on an occasion (Miller et al., 2007).

authors used repeated cross-sections from the General Social Survey in the United States to prove that men and women who drank earn 10% and 14% more, respectively, than abstainers. Issues of reverse causality however remain an obstacle in the assessment of this relationship and call for future research (Table 9).

**Table 9. Alcohol drinking**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Chatterji and DeSimone <i>Adolescent drinking and school dropout</i>	NBER Working Paper No. 11337 United States of America, 2005	National Longitudinal Survey of Youth 1979 (NLSY79) and young adults Multivariate regression analysis Instrumental variables	Adolescents' heavy drinking School dropout	Binge or frequent drinking among 15–16-year-old students lowered the probability of having graduated from or being enrolled in high school four years later by at least 11%.
Ellickson PL, Tucker JS, Klein DJ. <i>Ten-year prospective study of public health problems associated with early drinking</i>	<i>Pediatrics</i> , 111(5 Pt 1):949–955 United States of America, 2003	Longitudinal data: individuals recruited from 30 California and Oregon schools at grade 7 (1985) and again at grade 12 (1990) and age 23 (1995) Logistic regression analysis Huber variance estimates	Self-reported alcohol consumption: early non-drinkers, experimenters and drinkers Self-reported prevalence of academic difficulties	Early drinkers and experimenters were more likely than non-drinkers to report academic problems.
Dee TS, Evans WN <i>Teen drinking and education attainment: evidence from two-sample instrumental variables (TSIV) estimates</i> DeSimone J, Wolaver AM <i>Drinking and academic performance in high school</i>	NBER Working Paper No. 6082 United States of America, 1997 NBER Working Paper No. 11035 United States of America, 2005	1.3 million respondents from 1960–1969 birth cohorts in the 1990 Public-Use Microdata Sample (PUMS) Exploit within-state variation in alcohol availability over time 2001 and 2003 Youth Risk Behaviour Survey Multivariate regression analysis	Minimum legal drinking age (MLDA) High school completion, college entrance and completion Alcohol use, bingeing GPA scores	Changes in MLDA had small effects on educational attainment. Binge drinking slightly worsened academic performance. Impact was negligible for students who were less risk averse, heavily discounted the future or used other drugs. Effects remained significant after accounting for unobserved heterogeneity in risk-averse, future-oriented and drug-free students.
Koch S, Ribar D <i>A siblings analysis of the effects of alcohol consumption onset on educational attainment</i>	<i>Contemporary Economic Policy</i> 19(2):162–174 United States of America, 2001	Data on same-sex sibling pairs from 1979–1990 NLSY panels Family fixed effect Instrumental variables	Youthful alcohol drinking Educational attainment	Estimates of the schooling consequences of youthful drinking were very sensitive to specification issues. The actual effects of youthful drinking on education are likely to be small.
López-Frías M et al. <i>Alcohol consumption and academic performance in a population of Spanish high school students</i>	<i>Journal of Studies on Alcohol and Drugs</i> , 62(6):741–744 Spain, 2001	Students aged 14–19 years, attending high school during the academic year 1994–1995 in the city of Granada in southern Spain Multiple logistic regression analysis	Total alcohol consumption (grams (g) of alcohol per week and per day for three categories of alcoholic drinks: wine, beer and distilled spirits) Self-reported school performance	Risk of academic failure increased considerably when more than 150g of alcohol were consumed per week.

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Miller JW et al. <i>Binge drinking and associated health risk behaviors among high school students</i>	<i>Pediatrics</i> , 119(5):1035; author reply 1035–1036 United States of America, 2007	2003 National Youth Risk Behaviour Survey Multivariate logistic regression analysis	Different patterns of alcohol consumption, current drinking, binge drinking and other health risk behaviours Self-reported grades in school	Students who binge drank were more likely than both non-drinkers and current drinkers who did not binge to report poor school performance and involvement in other risky behaviours.
Renna F <i>Teens' alcohol consumption and schooling</i>	<i>Economics of Education Review</i> 27(1):69–78 United States of America, 2004	NLSY79 Two-stage probit with instrumental variables (alcohol-related policies)	Alcohol consumption High school graduation and on time graduation	Alcohol policies did not affect the dropout rate measured at the age of 25, but they did affect the probability that a student would graduate on time.
Yamada T, Kendix M, Yamada T <i>The impact of alcohol consumption and marijuana use on high school graduation</i>	<i>Health Economics</i> 5(1):77–92 United States of America, 1996	NLSY Multivariate regression analysis	Alcohol and marijuana use High school graduation	Increases in incidence of frequent drinking, liquor and wine consumption and marijuana use significantly reduced the probability of high school graduation.

## Drug use

Most of the studies investigating the relationship between drug use and school achievement focus on marijuana use. In this case all research similarly concludes that using marijuana resulted in a significant negative impact on both short- and long-term educational outcomes. However, as in the case of alcohol drinking, most of the evidence is based on data from the United States, which indicates a gap in research in other OECD countries. Again, although probably to a lesser extent, differences in perceptions and habits related to drugs between countries might account for significant variations in the estimated relationship between both factors

Concerning educational attainment, Bray et al. (2000) found a probability that marijuana users would drop out 2.3 times more than non-users in a sample from the United States. The lack of controls for unobservable variables and issues of nonrepresentativeness of the sample used, however, remained as obstacles to establishing a causal relationship between marijuana use and educational outcomes in this study.

A study by Roebuck, French and Dennis (2004) used a probit model and instrumental variable estimation (measures of religiosity) on a much larger sample of youth in the United States to show that marijuana users were more likely to be school dropouts and to skip school relative to non-marijuana users. Despite concerns over the validity of the instrument and the use of cross-sectional data, these results reinforce the hypothesis of causality, further confirmed by a more recent study by Chatterji (2006). This author proved, also using an instrumental variable approach on panel data from the United States, that past-month marijuana use in 10th and 12th grades may detract from educational attainment.

With regard to academic performance, most research indicates that it can be significantly affected by drug use. Marijuana use proved to be a determinant of school failure (grade repetition) among Spanish students according to Duarte, Escarioa and Molina (2006), who also found no significant correlation in the opposite direction using a maximum likelihood estimation on repeated cross-sections of a national survey. Pacula, Ross, and Ringel (2003) further concluded using a differences-in-differences estimation on panel data from the United States that marijuana use was statistically associated with a 15% reduction in performance on standardized mathematics tests. Finally, Caldeira et al. (2008) found that school absenteeism was one of the main cannabis-related problems among first-year college students in a sample in the United States (Table 10).

**Table 10. Marijuana use**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Bray JW et al. <i>The relationship between marijuana initiation and dropping out of high school</i>	<i>Health Economics</i> , 9(1):9–18 United States of America, 2000	Longitudinal survey of 1392 adolescents aged 16–18 years Logit regression analysis	Marijuana initiation School dropout	Marijuana users' odds of dropping out of school were about 2.3 times that of non-users.
Caldeira KM et al. <i>The occurrence of cannabis use disorders and other cannabis-related problems among first-year college students</i>	<i>Addictive Behaviors</i> , 33:397–411 United States of America, 2008	Participants recruited as part of the College Life Study at a public university in the United States mid-Atlantic region Multivariate logistic regression analysis	Use of cannabis in past year Missed classes in past year	Concentration problems (40.1%), driving while high (18.6%) and missing class (13.9%) were among the most prevalent cannabis-related problems.
Chatterji P <i>Illicit drug use and educational attainment</i>	<i>Health Economics</i> , 15:489–511 United States of America, 2006	National Education Longitudinal Study Multivariate regression analysis, fixed effects and instrumental variables (measure of prices and availability)	Alcohol, marijuana and cocaine use Number of years of schooling completed by 2000 interview	It is likely that past-month marijuana use in grades 10 and 12 and lifetime cocaine use by grade 12 may detract from educational attainment.
Duarte R, Escarioa JJ, Molina JA <i>Marijuana consumption and school failure among Spanish students</i>	<i>Economics of Education Review</i> , 25:472–481 Spain, 2005	Consecutive waves from the Spanish Surveys on Drug Use in the School Population (1996, 1998 and 2000) Maximum likelihood estimation	Use of marijuana during the last 30 days Grade repetition	Marijuana use was a determinant of school failure among Spanish students.
Ellickson PL et al. <i>Antecedents and outcomes of marijuana use initiation during adolescence</i>	<i>Preventive Medicine</i> , 39:976–984 United States of America, 2004	Students in Project ALERT for middle-school students, 30 control and treatment schools drawn from 8 California and Oregon districts Multivariate regression analysis	Self-reported marijuana use Self-reported frequency of cigarette and alcohol use Grades at grades 7 and 9 (1 = mostly As to 5 = mostly Fs)	Grade 7 initiates were more likely than grade 9 initiates to engage in hard drug use, earn poor grades and have low academic intentions.
Pacula RL, Ross KE, Ringel J <i>Does marijuana use impair human capital formation?</i>	NBER Working Paper No. 9963 United States of America, 2003	National Education Longitudinal Survey Difference-in-differences estimates	Marijuana use Performance on standardized tests	Marijuana use was statistically associated with a 15% reduction in performance on standardized mathematics tests.
Roebuck MC, French M, Dennis ML <i>Adolescent marijuana use and school attendance</i>	<i>Economics of Education Review</i> , 23:133–141 United States of America, 2004	1997 and 1998 National Household Surveys on Drug Abuse: sample of 15168 adolescents aged 12–18 who had not completed high school Zero-inflated negative binomial regression analysis Instrumental variable for marijuana use (religiosity measures) First-stage ordered probit model	Marijuana use during the past year Adolescent school dropout Number of days truant in the past 30	All marijuana users are more likely to be school dropouts and, conditional on being enrolled in school, skip more school days than non-users.



## Smoking

The evidence on the association between smoking and education reveals a negative correlation between them. In this sense, Cook and Hutchinson (2006) found using data from the United States that smoking in grade 11 was a powerful predictor of whether students finished high school and, if they did, whether they matriculated in a four-year college, while a Collins et al. (2007) study of 1958 data from the United Kingdom showed that teen smoking was a significant predictor of academic performance, with higher smoking rates increasing the likelihood of failure. Causality, however, cannot be inferred from these findings.

In line with both of the above, an analysis by Ellickson, Tucker and Klein (2001) of longitudinal, self-reported data from the United States concluded that compared with non-smokers early smokers were at higher risk of low academic achievement and behavioural problems at school and were more likely to drop out.

Additionally, Yolton et al. (2005) used data from the United States to find a noteworthy inverse association between environmental tobacco smoke (ETS) exposure and cognitive development among children even at extremely low exposure levels. Different methodological issues, however, call for a cautious interpretation of these results.

Finally, Ding et al. (2006) more recently found in their innovative analysis of Georgetown (United States) Adolescent Tobacco Research data that smokers tend to have lower GPAs; they used genetic markers as instrumental variables to deal with endogeneity and measurement problems (Table 11).

**Table 11. Smoking**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Collins BN et al. <i>Adolescent environmental tobacco smoke exposure predicts academic achievement test failure</i>	<i>Journal of Adolescent Health</i> , 41:363–370 United Kingdom, 2007	Longitudinal analysis of birth cohort data, including 6380 pregnant women and offspring from the 1958 National Child Development Study (NCDS) Logistic regression analysis	Adolescent smoking status Unverified, retrospective, self-reported achievement when offspring was 23 years old (pass versus fail, determined by performance on nationally standardized achievement tests taken at 16 (O-Level) and 18 years (A-Level))	Teen smoking was a significant predictor of O- and A-Level performance, with higher smoking rates increasing the likelihood of failure.
Cook P, Hutchinson R <i>Smoke signals: adolescent smoking and school continuation</i>	NBER, Working Paper No. 12472 United States of America, 2006	NLSY79 Multivariate logit regression analysis	Choices of whether to smoke or drink School continuation	Smoking in grade 11 was a powerful predictor of whether students finished high school and, if so, whether they matriculated in a four-year college.
Ding W et al. <i>The impact of poor health on education: new evidence using genetic markers</i>	NBER Working Paper No. 12304 United States of America, 2006	Data from Georgetown Adolescent Tobacco Research (GATOR) study, longitudinal 1999–2003	Smoking, depression, attention deficit hyperactivity disorder (ADHD), body mass index (BMI) GPA	Depression and obesity both lead to a decrease of 0.45 GPA points on average (i.e. roughly one standard deviation); substantial heterogeneity in the impact of health on academic performance across genders: in females, academic performance is strongly and negatively affected by poor physical and mental health conditions; hardly any effect for males.

**Table 11. contd**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Ellickson PL, Tucker JS, Klein MS <i>High-risk behaviors associated with early smoking: results from a 5-year follow-up</i>	<i>Journal of Adolescent Health</i> , 28:465–473 United States of America, 2001	Longitudinal self-reported data from 4327 California and Oregon students Multivariate logistic regression Computed Huber variance estimates	Smoking in grade 7 (smoked 3 or more times in the past year or at all in the past month) Academic problems in grade 7: skipped school or was sent out of class more than once in the last year, missed five or more days of school during the current year, earned grades of C or worse and ever repeated a grade. In grade 12: dropped out, frequent absences and being sent out of the classroom, being suspended and dropping out of school	Compared with non-smokers, early smokers were at higher risk for low academic achievement and behavioural problems at school.
Yolton K et al. <i>Exposure to environmental tobacco smoke and cognitive abilities among U.S. children and adolescents</i>	<i>Environmental Health Perspectives</i> , 113 (1):98–103 United States of America, 2005	Third National Health and Nutrition Examination Survey (NHANES III), conducted from 1988 to 1994 Multivariate logistic regression analysis	Serum cotinine used as a biomarker of environmental tobacco smoke exposure Cognitive and academic abilities (reading and mathematics subtests of WRAT-Revised and design and digit span subtests of the Weschler Intelligence Scale for Children–III (WISC-III) 6–11-year-old	There was an association between ETS exposure and cognitive deficits in children even at extremely low levels of exposure.

### Poor nutrition

The Currie (2008) literature review on the relationship between poor nutrition and education focused mostly on developing countries. Currie highlights that it is not as easy to prove this correlation in richer countries. Increasing evidence in the industrialized world mostly in connection with breakfast programmes and the development of cognitive abilities and/or academic performance shows that insufficient nutrition can have a relevant impact on education.

Studies evaluating the impact of WIC (United States Special Supplement Nutrition Program for Women, Infants, and Children) have found for instance a positive correlation with educational outcomes of children from participant families (Currie, 2008). Confirming these findings, a review of the evidence on school breakfast programmes' effectiveness conducted by Cueto (2001) concluded that school breakfast interventions can have a positive effect on the nutritional status of children, on school attendance and probably on dropout rates. As pointed out by Grantham-McGregor (2005), however, most of the small experiments used to evaluate the correlation between nutrition and education are faced with methodological problems that need to be considered in the interpretation of their results.

Alaimo, Olson and Frongillo (2001) found that 6–11-year-old, food-insufficient children in the United States had significantly lower arithmetic scores and were more likely to have repeated a grade, have seen a psychologist and have had difficulty getting along with other children; while food-insufficient teenagers were more likely to have seen a psychologist,

have been suspended from school and have had difficulty getting along with other children. Given that the authors used regular regression analysis—although stratified by risk level and adjusting for some confounding factors—and used self-reported measures of nutrition in the analysis, biases due to endogeneity and measurement errors could be expected.

Torres et al. (2007) concluded that rural students in a Spanish province ingested more carbohydrates and fewer lipids at breakfast and that academic performance was significantly better in rural children than in those from urban areas. These results however need to be regarded in light of the fact that the study was limited to a small sample of children in only one province, did not include controls and was not fully randomized (Table 12).

**Table 12. Poor nutrition**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Alaimo K, Olson C, Frongillo E <i>Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development</i>	<i>Pediatrics</i> , 108:44–53 United States of America, 2001	NHANES III Multivariate linear and logistic regression analysis stratified by risk level	Food insufficiency Cognitive, academic and psychosocial measures in general and within lower risk and higher risk groups	6–11-year-old, food-insufficient children had significantly lower arithmetic scores and were more likely to have repeated a grade, have seen a psychologist and have had difficulty getting along with other children. Food-insufficient teenagers were more likely to have seen a psychologist, have been suspended from school and have had difficulty getting along with other children. The associations between food insufficiency and children's outcomes varied by level of risk.
Torres MD et al. <i>Breakfast, plasma glucose and beta-hydroxybutyrate, body mass index (BMI) and academic performance in children from Extremadura, Spain</i>	<i>Nutrición Hospitalaria</i> , 22(4):487–490 Spain, 2007	Representative samples of schoolchildren from Extremadura, Spain, 3 to 12 years old Random cluster sampling in schools	Breakfast composition Academic performance reported by teachers	Rural population ingested more carbohydrates and fewer lipids than urban population at breakfast. Academic performance was significantly better in rural children than urban ones. BMI was significantly higher in the urban than rural children.

### Obesity and overweight

According to Taras and Potts-Datema (2005c), although an increasing body of evidence shows a correlation between obesity and overweight and educational outcomes, causality has not been proved to date, and only some studies such as Schwimmer, Burwinkle and Varni (2003) attribute to obesity a significant causal effect on education through higher absenteeism rates. Since the Taras and Potts-Datema (2005c) review, new and relevant evidence has become available, mostly confirming that a significant correlation exists, although still not conclusive with regard to causality.

Kaestner and Grossman (2008) found in their analysis of panel youth data from the United States that generally children who are overweight or obese have achievement test scores that are about the same as children with average weight. However, other recent studies suggest otherwise. Datar and Sturm (2006) and Cawley and Spiess (2008) concluded that a negative relationship exists between overweight and education, with significant gender differences.

Datar and Sturm's (2006) analysis of a sample of children in the United States who entered kindergarten in 1998 found that moving from not-overweight to overweight status between kindergarten entry and the end of third grade was significantly associated with reductions in test scores only for girls. Cawley and Spiess (2008), on the contrary, concluded from their study of a German sample that obesity was a significant risk factor for lagged development in verbal skills, social skills and activities of daily living only among boys. Although both studies used panel data, which allowed controlling for unobserved time-invariant variables, causality is not yet clear, since biases due to other omitted factors that vary over time were not totally eliminated. A paper by Falkner et al. (2001) based on data from the United States seems to confirm the hypothesis that overweight can have a significant impact on education. However, and overall, further research that corrects for endogeneity and makes use of more recent datasets would help establish the causal link (if any) with a higher degree of certitude (Table 13).

**Table 13. Obesity and overweight**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Cawley J, Spiess CK <i>Obesity and developmental functioning among children aged 2–4 years (also reported in Obesity and skill attainment in early childhood, NBER Working Paper)</i>	Deutsches Institut für Wirtschaftsforschung Berlin Discussion Paper No. 786 SOEP [German Socioeconomic Panel] Paper No. 97 Germany, 2008	German Socioeconomic Panel Multivariate regression analysis	BMI and obesity status Verbal skills, activities of daily living, motor skills and social skills	Among boys, obesity was a significant risk factor for lagged development in verbal skills, social skills and activities of daily living. Among girls, weight generally does not have a statistically significant association with these developmental outcomes.
Datar A, Sturm R <i>Childhood overweight and elementary school outcomes</i>	<i>International Journal of Obesity</i> , 30(9):1449–1460 United States of America, 2006	Nationally representative sample of children in the United States who entered kindergarten in 1998, with longitudinal data on BMI and school outcomes at kindergarten entry and end of third grade Multivariate linear and logistic regression analysis	BMI and indicators of overweight status Mathematics and reading standardized test scores, teacher reports of internalizing and externalizing behaviour problems, social skills and approaches to learning, school absences and grade repetition	Moving from not-overweight to overweight between kindergarten entry and end of third grade was significantly associated with reductions in test scores, teacher ratings of social-behavioural outcomes and approaches to learning among girls. However, this link was mostly absent among boys.
Falkner NF et al. <i>Social, educational and psychological correlates of weight status in adolescents</i>	<i>Obesity Research</i> , 9(1):33–42 United States of America, 2001	Population-based sample of 4742 male and 5201 female public school students in grades 7, 9 and 11 Multivariate regression analysis	BMI Self-reported academic performance	Obese girls were 1.51 times more likely to report being held back a grade and 2.09 times more likely to consider themselves poor students compared with average-weight girls. Obese boys were 1.46 times more likely to consider themselves poor students, and 2.18 times more likely to expect to quit school.
Kaestner R, Grossman M <i>Effects of weight on children's educational achievement</i>	NBER Working Paper No. 13764 United States of America, 2008	NLSY79 First differences instrumental variable	Weight Educational achievement as measured by the scores on the PIAT in mathematics and reading	Generally, children who are overweight or obese had achievement test scores that were about the same as children with average weight.

### **The impact of physical activity on educational outcomes**

Interest in the potential, positive impact of physical activity on educational outcomes has accelerated quite recently. In 2005 Taras and Potts-Datema published a comprehensive review of the existing research on this relationship and overall concluded that despite evidence on short-term improvements related to physical activity, such as to concentration, long-term improvements in academic achievement were not well substantiated (Taras and Potts-Datema, 2005c).

Trudeau and Shepherd (2008) in a more recent review of quasi-experiments assessing the effect of physical education and physical activity in schools highlighted that allocating up to an additional hour per day of curricular time to physical activity may result in small absolute gains in GPA. According to these authors, cross-sectional observations showed a positive association between academic performance and physical activity, but physical fitness did not seem to show such association.

Recent experiments have confirmed these findings. Through a randomized experiment in a sample of German high school students, Henning Buddea et al. (2008) found that 10 minutes of coordinative exercise (CE) and of a normal

sports lesson (NSL) significantly improved concentration and attention. Singh and McMahan (2008) assessed the link between physical fitness and overall academic achievement among a wider sample of elementary school students in California and found that they were positively related. While most of the 10 lowest scoring schools did not have a designated physical education teacher, all of the 10 highest scoring schools did have such teachers and followed the physical education guidelines recommended by the state’s education board. However, as the authors highlight, it is not possible to infer causality from the results due to methodological issues. Castelli et al. (2007) confirmed these results using a different sample of secondary-school students in the United States.

In addition, Carlson et al. (2008) concluded, using panel national data from the United States, that a small but significant benefit for academic achievement in mathematics and reading was observed for girls enrolled in higher amounts of physical education, but that the same did not have any impact on academic achievement among boys (Table 14).

**Table 14. Physical exercise**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Carlson SA et al. <i>Physical education and academic achievement in elementary school: data from the early childhood longitudinal study</i>	<i>American Journal of Public Health</i> , 98(4):721–727 United States of America, 2008	Early Childhood Longitudinal Study, kindergarten class of 1998–1999 Multivariate regression analysis	Time spent in physical education (minutes per week) reported by classroom teachers Academic achievement (mathematics and reading) scored on an item response theory scale	A small but significant benefit for academic achievement in mathematics and reading was observed for girls enrolled in more physical education. More physical education was not associated with academic achievement among boys.
Castelli DM et al. <i>Physical fitness and academic achievement in third- and fifth-grade students</i>	<i>Journal of Sport and Exercise Psychology</i> , 29(2):239–252 United States of America, 2007	259 public school students in grades 3 and 5	Tests of physical fitness, BMI and aerobic capacity Total academic achievement, mathematics achievement and reading achievement.	Field tests of physical fitness were positively related to academic achievement. Specifically, aerobic capacity was positively associated with achievement, whereas BMI was inversely related.
Henning Buddea H et al. <i>Acute coordinative exercise improves attentional performance in adolescents</i>	<i>Neuroscience Letters</i> , 441(2):219–223 Germany, 2008	Randomized experiment	10 minutes of CE and NSL d2-test (test of attention and concentration) results	CE and NSL enhanced d2-test performance from pre- to post-test significantly. Those who had CE were more effective in completing the concentration and attention task.
Singh S, McMahan S <i>An evaluation of the relationship between academic performance and physical fitness measures in California schools</i>	<i>Californian Journal of Health Promotion</i> , 4(2):207–214 United States of America, 2006	Elementary schools in Orange County, California Correlation analysis	Physical fitness test scores Reading, mathematics and science scores on the California Standards test	Most of the 10 lowest scoring schools did not have a designated physical education teacher, and all of the 10 highest scoring schools did and followed the physical education guidelines recommended by the California Education Board.

## Impact of health conditions on educational outcomes: detailed findings

Sleeping problems, mental health problems (broadly understood as anxiety and depression problems) and asthma are some of the most prevalent health conditions with relevant potential impacts on future developmental outcomes among schoolchildren and adolescents (Currie, 2008; Tara and Potts-Datema, 2005a). Although different reviews of the literature analysing the correlation between most of these problems and educational outcomes exist, new or additional research findings are considered here.

Potential endogeneity and reverse causality remain the main obstacles in the estimation of the effect of these variables on education. In addition, the measurement of health conditions still widely relies on self-reported (and hence often biased) health indicators. Some general conclusions, however, can be outlined from the existing research.

- Sleeping disorders and academic performance tend to be inversely correlated, although there is a need to address measurement and other methodological problems to properly assess causality in this relationship.
- Anxiety and depression appear to be significantly and negatively associated with both short- and long-term educational outcomes. Further research is particularly required in the case of depression and its effect on education.
- Asthma is clearly correlated with school attendance, but does not seem to show such a strong connection with performance measured through scores.
- Overall, children’s and adolescents’ health proves to have an effect on different measures of educational outcomes, despite persistent measurement and endogeneity problems in the assessment of this relationship.

### *Sleeping disorders*

Taras and Potts-Datema’s (2005b) review on the relationship between sleep disorders and education complemented the earlier reviews by Blunden et al. (2001) and Wolfson and Carskadon (2003). As highlighted by all of these reviews, few studies identify a relationship between sleeping disorders and academic performance, and those that do face three major shortcomings.

The first shortcoming is that data collection to date mostly relies on parents’, teachers’ and students’ self-reports, which demand validation (Gibson et al., 2006). Future studies would therefore ideally go beyond subjective and probably biased self-reported measures. Second, as stated by Fallone et al. (2001), definitions of what is considered “good” versus “poor” sleep vary. Gibson et al. (2006) asserted that it is the quality and not the quantity of sleep that might need to be considered, generating particular measurement challenges. Third, most of the studies aiming to establish a statistical relationship between different measures of sleep disorders and education rely on small, school-based experiments that often are not fully randomized.

Additional research on this relationship includes a study by Urschitz et al. (2003), which concluded that German children who snored habitually had at least twice the risk of performing poorly at school, with this association becoming stronger with increasing snoring frequency. Gibson et al. (2006) provide further evidence of this direct link. The authors found that sleep deprivation and excessive daytime sleepiness were common in two cross-sectional samples of Canadian high school students and were associated with a decrease in academic achievement and extra-curricular activity. Both studies present methodological limitations. While the Urschitz et al. (2003) analysis did not adequately address endogeneity issues – omitted variables and reverse causality – and included self-reported measures of sleeping problems – parents’ responses – the Gibson et al. (2006) experiment was not totally randomized: participants were informed and gave consent prior to participation.

Also using Canadian data, Touchette et al. (2007) estimated that shortened sleep duration, especially before the age of 41 months, is associated with externalizing problems such as hyperactivity-impulsivity (HI) and lower cognitive performance on neurodevelopmental tests (Table 15).

**Table 15. Sleeping problems**

<b>Author Title</b>	<b>Source Country, year</b>	<b>Data Methodology</b>	<b>Health indicator Education indicator</b>	<b>Findings</b>
Drake C et al. <i>The pediatric daytime sleepiness scale (PDSS): sleep habits and school outcomes in middle-school children</i>	<i>Sleep</i> , 26(4):455–458 United States of America, 2003	150 11–15-year-old students in grades 6, 7 and 8 from a public middle school in Dayton, Ohio One-way analyses of variance and trend analyses	Levels of daytime sleepiness School achievement, rates of absenteeism and school enjoyment	Daytime sleepiness was related to reduced educational achievement and other negative, school-related outcomes.

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Gibson ES et al. <i>“Sleepiness” is serious in adolescence: two surveys of 3235 Canadian students</i>	<i>BMC Public Health</i> , 6:116 Canada, 2006	Cross-sectional survey of 2201 high school students in the Hamilton Wentworth District School Board and the Near North District School Board in Ontario in 1998/1999  Survey in 2001–2002 of 1034 students in the Grand Erie District School Board in Ontario  Generalized estimating equation (GEE)	Epworth Sleepiness Scale (ESS) was used to measure self-reported sleepiness  Self-reported grades, school attendance and extracurricular activity	Sleep deprivation and excessive daytime sleepiness were common in both student samples and were associated with a decrease in academic achievement and extracurricular activity.
Touchette E et al. <i>Associations between sleep duration patterns and behavioral/ cognitive functioning at school entry</i>	<i>Sleep</i> , 30(9):1079–1080 Canada, 2007	Sample of births from 1997 to 1998 in a Canadian province  Weighted, multivariate logistic regression analysis	HI, inattention and daytime sleepiness scores  Peabody Picture Vocabulary Test–Revised (PPVT-R) was administered at 5 years of age and the Block Design subtest WISC-III at 6 years	Shortened sleep duration, especially before the age of 41 months, was associated with externalizing problems such as HI and lower cognitive performance on neurodevelopmental tests.
Urschitz MS et al. <i>Snoring, intermittent hypoxia and academic performance in primary school children</i>	<i>American Journal of Respiratory and Critical Care Medicine</i> , 168(4):464–468 Germany, 2003	27 of the 59 public primary schools within the city limits of Hannover, Germany  Unconditional logistic regression  Class fixed effects	Symptoms of sleep-disordered breathing and intermittent hypoxia during sleep  Scores in the most recent school report	Children who snored habitually had at least twice the risk of performing poorly at school, with this association becoming stronger with increasing snoring frequency. The study found a weak association between IH and poor academic performance in these primary schoolchildren; the association was not, however, independent of snoring.
Wolfson MR, Carskadon MC <i>Sleep schedules and daytime functioning in adolescents</i>	<i>Child Development</i> , 69(4):875–887 United States of America, 1998	Sleep Habits Survey administered in homeroom classes to 3120 high school students at four public high schools from three Rhode Island school districts  Multivariate analysis of variance	Self-reported total sleeping time  Self-reported school success	Students with shorter and less regular sleep reported lower school performance.

## Mental health and well-being

The evidence on the effect of mental health problems on education, although scarce relative to the high and increasing incidence of these problems throughout industrialized countries, generally suggests a strong association between these factors. Reverse causality issues are in this case better addressed in the existing literature, which mostly follows students over time (McLeod and Kaiser, 2004) and, as in Currie and Stabile (2007), applies sibling fixed-effects models.

Concerning anxiety and academic performance, Mazzone et al. (2007) confirmed previous research findings in their analysis of Italian students: the prevalence of abnormally high, self-reported levels of anxiety increased in frequency with age and was negatively associated with school performance. In line with these results Spernak et al. (2006) concluded using data from Head Start children in the United States that measures of mental health status were significantly and independently associated with academic achievement scores in kindergarten and third grade. Currie

and Stabile (2007) in turn found that different mental health conditions can have large negative effects on future test scores and schooling attainment.

Focusing on educational attainment, Van Ameringen, Mancini and Farvolden (2003) studied a sample of Canadian children and concluded that anxiety disorders and especially generalized social phobia were associated with premature withdrawal from school. While Egger, Costello, and Angold (2003) showed in their analysis of a sample of students in the United States that pure, anxious school refusal was significantly associated with depression and separation anxiety disorder.

The specific impact of children's and adolescents' depression on educational outcomes has been barely investigated to date, partly due to the lack of adequate longitudinal data. One of the main studies on this relationship is Fletcher's (2007), which used longitudinal data from the United States and found a robust negative association between depression in high school and subsequent educational attainment; the association was mainly confined to female students. Female adolescents with depression were 3.5 percentage points less likely to graduate from high school, and depressed adolescents were almost six percentage points less likely to enrol in college, with the effect being larger for females – the decrease in attending a four-year college for females was 10 percentage points. However, causality cannot be inferred from these results as the effect of unobserved heterogeneity was not controlled for (Table 16).

**Table 16. Mental health and well-being**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Currie J, Stabile M <i>Mental health in childhood and human capital</i>	NBER Working Paper No. 13217 Canada and United States of America, 2007	Canadian National Longitudinal Survey of Children and Youth (NLSCY) and NLSY Fixed effects	Hyperactivity score, emotional behaviour score and aggressive behaviour score Grade repetition, mathematics scores, reading scores and special education	Mental health conditions, especially ADHD, had large negative effects on future test scores and schooling attainment, regardless of family income and maternal education.
Egger HL, Costello, JE, and Angold A <i>School refusal and psychiatric disorders: a community study</i>	<i>American Academy of Child and Adolescent Psychiatry</i> , 42(7):797–807 United States of America, 2003	Data from eight annual waves of structured psychiatric interviews with 9–16-year-olds and their parents from the Great Smokey Mountains Study Regression analysis	Psychiatric disorders incidence: anxiety and depression among others Anxious school refusal and truancy	Anxious school refusal and truancy were distinct but not mutually exclusive and were significantly associated with psychopathology and adverse experiences at home and in school.
Fletcher JM <i>Adolescent depression: diagnosis, treatment and educational attainment</i>	<i>Health Economics</i> , 17(11):1215–1235 United States of America, 2008	National Longitudinal Study of Adolescent Health (adolescents in grades 7 through 12) Multivariate regression analysis Log regression, probit regression	Depressive symptoms School dropout, college enrolment and enrolment in a four-year college	Female adolescents with depression were 3.5 percentage points less likely to graduate from high school. Depressed adolescents were almost 6 percentage points less likely to enrol in college; the effect was larger for females. The decrease in attending a four-year college for females was 10 percentage points.
McLeod J D, Kaiser K <i>Childhood emotional and behavioral problems and educational attainment</i>	<i>American Sociological Review</i> , 69:636–658 United States of America, 2004	Children of the NLSY data set (1986–2000) Multivariate logistic regression analysis	Child emotional and behavioural problems (Behavior Problems Index) reported by mothers in 1986 and 1990 and self-reported in 1994 and 1998. Depression measure: Center for Epidemiological Studies: Depression Scale Dropout and college enrolment, mathematics and reading scores (PIAT), mothers' and children's reports on grade repetition, child's self-reports of having received a high school degree by 2000 and having entered college as of 2000	Internalizing and externalizing problems at ages 6–8 significantly and strongly diminished the probability of receiving a high school degree. Among youth who receive such degree, externalizing problems diminished the probability of subsequent college enrolment.



Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Mazzone L et al. <i>The role of anxiety symptoms in school performance in a community sample of children and adolescents</i>	<i>BMC Public Health</i> , 7:347 Italy, 2007	Samples of elementary (age 8–10 years), middle (age 11–13 years), and high school (age 14–16 years) children recruited from four public schools in a predominantly middle-class community in Catania, Italy $\chi^2$ test was applied to analysis of categorical data. Continuous variables were compared across categorical variables using Student's t-test or analysis of variance (ANOVA). When the omnibus ANOVA was significant, post-hoc contrasts between a pair of groups (Tukey-Kramer Honestly Significant Difference test) were conducted.	Multidimensional Anxiety Scale for Children Current academic grades	The prevalence of abnormally high self-reported levels of anxiety increased in frequency with age and were negatively associated with school performance.
Van Ameringen M, Mancini C, Farvolden P. <i>The impact of anxiety disorders on educational achievement</i>	<i>Journal of Anxiety Disorders</i> , 17(5):461–471 Canada, 2003	201 patients meeting criteria from the <i>Diagnostic and Statistical Manual of Mental Disorders IV</i> for a primary anxiety disorder	Self-reported measures of anxiety, depression and social adjustment Self-reported school achievement, rates of absenteeism and school enjoyment	Anxiety disorders, perhaps especially generalized social phobia, are associated with premature withdrawal from school.

## Asthma

The Taras and Potts-Datema (2005d) literature review on the relationship between asthma and education concluded that although a positive correlation between school absenteeism and asthma could be established, only a third of the studies reviewed found that asthma had a significant impact on scores. In line with these findings Silverstein et al. (2001) provided further evidence that although in a specific community children in the United States with asthma had two excess days of absenteeism, their school performance was similar to that of children without asthma.

Recent studies in the United States by Bonilla et al. (2006) and Moonie et al. (2008) reached similar conclusions. The first found that children with known asthma missed on average two more days of school than children with low or high probability of asthma. While the second concluded that although an inverse relationship between absenteeism and performance on standardized tests could be established, there was no overall difference in test performance between those with and without asthma. In addition, Halterman et al. (2001) argued that asthmatic children had lower scores on a test of school readiness skills based on the analysis of a comprehensive survey of children beginning kindergarten in 1998 in an urban school system in New York state (Table 17).

**Table 17. Asthma**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Bonilla S et al <i>School absenteeism in children with asthma in a Los Angeles inner city school</i>	<i>Pediatrics</i> , 147(6):802–806 United States of America, 2006	528 students of predominantly Hispanic ethnicity from a Los Angeles inner-city school ANOVA	Known asthma, high probability of asthma and low probability of asthma Average number of school days missed	Children with known asthma missed on average two more days of school than those with low or high probability of asthma.
Halterman JS et al. <i>School readiness among urban children with asthma</i>	University of Rochester Medical Center (2006, February 7) United Kingdom, 2001	Comprehensive survey of children beginning kindergarten in 1998 in the urban school system in Rochester, New York, collected parent reports of demographic, medical and developmental data Linear and logistic regression analysis	Asthma incidence Scores on a test of school readiness skills	Asthmatic children had lower scores on the test of school readiness skills.
Silverstein MD et al. <i>School attendance and school performance: a population-based study of children with asthma</i>	<i>Pediatrics</i> , 139(2):278–83 United States of America, 2001	Previously identified Rochester, Minnesota, cohort of children with asthma and age- and sex-matched children without asthma Matching estimates	Asthma incidence School attendance, standardized achievement test scores, GPA, grade promotion and class rank of graduating students	Although children with asthma had 2 excess days of absenteeism, the school performance of children with asthma was similar to that of children without asthma.
Moonie S et al. <i>The relationship between school absence, academic performance, and asthma status</i>	<i>Journal of School Health</i> , 78(3):140–148 United States of America, 2008	Cross-section, 3 812 students (aged 8–17 years) who took the Missouri Assessment Program (MAP) standardized test during the 2002–2003 academic year Chi-squared test of independence used to assess the relationship between the presence of asthma and test-level performance. The relationship between absenteeism and the presence of asthma was assessed using ANOVA.	Presence of asthma and asthma severity level Absenteeism and standardized test performance	After adjusting for covariates, a significant inverse relationship was found between absenteeism and test performance on the MAP in all children. There was no overall difference in test achievement between those with and without asthma.

### General health status indicators

Most of the few studies that attempted to estimate the overall impact of health on educational outcomes conclude that health during childhood and adolescence can have a significant effect on both academic performance and educational attainment. Particular difficulties in the assessment of this relationship include the definition of a measurable indicator of overall health and endogeneity issues.

Self-reported measures of health involve measurement error problems, as highlighted in previous sections, while the use of a set of specific conditions might not provide a complete picture. How health is to be objectively measured remains a hard fought research question. Case, Fertig and Paxson (2005) considered the incidence of different chronic conditions during childhood as an indicator of health status and estimated their impact on O-levels<sup>5</sup> passed. On average each childhood condition at age 7 was associated with a 0.3 reduction in the number of O-levels passed, and each condition at age 16 with an extra 0.2 reduction.

<sup>5</sup> The Ordinary Level (O-level) exams used to be subject-based qualifications taken at the end of secondary schools at the age of 16 in the British educational system. They have recently been replaced by a new system, the General Certificate of Secondary Education.

Guo and Harris (2000) used measures of child ill health as overall health indicators to find that poor child health at birth was an intervening factor in children’s intellectual development in a sample of young people in the United States. Kaestner and Corman (1995), on the other hand, found evidence using data from the same survey that the relationship between health during childhood and cognitive development was weak.

At the same time, endogeneity (in particular resulting from reverse causality) further deters an accurate estimation of the causal relationship between health and education. Recent attempts to tackle these problems used panel data and within-siblings models (Smith et al., 2008), twins samples (Oreopoulos et al., 2008) or dynamic models (Gan and Gong, 2007). Smith et al. (2008) is one of the most complete and recent studies attempting to assess the connection between adult self-reports of general childhood health and mean schooling. Using panel data from the United States and within-family and across-siblings models to control for the effect of family characteristics, the author found that those with excellent or very good health achieved a third of a year more schooling than those whose health was worse. Similarly, Oreopoulos et al. (2008) made use of a Canadian twins sample to correct for endogeneity and concluded that infant health is a strong predictor of high school completion.

Finally, Gan and Gong (2007) attempted to clarify the mechanisms by which health and education interact using a dynamic model that allowed for several potential links between health and education outcomes. Using panel data from the United States, the authors concluded that an individual’s health status measured by the probability of sickness significantly affects academic success. According to their results, experiencing sickness before the age of 21 decreases education on average by 1.4 years (Table 18).

**Table 18. General health**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Case A, Fertig A, Paxson C <i>The lasting impact of childhood health and circumstance</i>	<i>Journal of Health Economics</i> , 24:365–389 United Kingdom, 2005	The 1958 National Child Development Study Multivariate regression analysis	Chronic health conditions at ages 7 and 16 O-level exams the child has passed by age 16	On average, each childhood condition was associated with a 0.3 reduction in O-levels at age 7 and an extra 0.2 reduction at age 16. Chronic conditions at age 7 had a larger association with educational attainment for all measures of human capital investment than did chronic conditions at age 16.
Ding W et al. <i>The impact of poor health on education: new evidence using genetic markers</i>	NBER Working Paper No. 12304 United States of America, 2006	GATOR study of a longitudinal dataset of adolescents that combines information from a series of five questionnaires given over four years of high school (1999–2003) along with four genetic markers Genetic markers across individuals as instrumental variables for health outcomes	ADHD, depression and obesity (genetic markers) GPA scores	Depression and inattention both led to a decrease of 0.5 GPA points on average. Mental and physical conditions show a strong correlation for females, not males.
Gan Li, Gong G <i>Estimating interdependence between health and education in a dynamic model</i>	NBER Working Paper No. 12830 United States of America, 2007	NLSY79 Structural equation model and four-stage estimation method	Probability of sickness Passing or failing a grade (high-study and low-study types)	An individual’s health status affected his or her academic success.

**Table 18. contd**

Author Title	Source Country, year	Data Methodology	Health indicator Education indicator	Findings
Guo G, Harris KM <i>The mechanisms mediating the effects of poverty on children's intellectual development</i>	<i>Demography</i> , 37(4): 431–447 United States of America, 2000	NLSY Structural equation model Multivariate unweighted regression	Child's ill health at birth and in childhood Scores on different tests measuring cognitive development (PIATR, PIAT, PPVT-R)	Cognitive stimulation in the home and poor child health at birth were mediating factors that influenced children's intellectual development.
Kaestner R, Corman H <i>The impact of child health and family inputs on child cognitive development</i>	NBER Working Paper No. 5257 United States of America, 1995	NLSY Multivariate regression analysis, child fixed effects	Limiting conditions requiring treatment in last 12 months, number of illnesses in last 12 months and serious illnesses PIAT scores	A weak relationship existed between several measures of child health and child cognitive development.
Ludwig J, Miller D <i>Does Head Start improve children's life chances? Evidence from a regression discontinuity design</i>	University of California Discussion paper United States of America, 2006	United States Office of Equal Opportunity (OEO) data sources and data from a special tabulation by the United States Census Bureau on 1990 census data to measure long-term schooling outcomes Discontinuity design	Head Start participation and funding High school completion, high school graduation rate, discontinuity in schooling and years of school completed	A discontinuity existed at the OEO cutoff in educational attainment in the 1990 census.
Smith JP <i>The impact of childhood health on adult labor market outcomes</i>	UCD (University College Dublin) Geary Institute Labor and Population Working Paper 14/2008 United States of America, 2008	Data derived from Panel Survey of Income Dynamics (PSID) following groups of siblings and their parents for 30 years Log-linear regression analysis with controls (demographic factors and family characteristics) Across siblings, within-fixed effects	Self-reports about general childhood health status Mean schooling	Respondents who self-reported excellent or very good health achieved a third of a year more schooling than those who reported worse health, and the impact was significant.
Spernak SM et al. <i>Child health and academic achievement among former Head Start children</i>	<i>Children and Youth Services Review</i> , 28(10):1251–1261 United States of America, 2006	Former Head Start children who participated in the National Public School-Head Start Transition Demonstration Study (NTDS) as they entered kindergarten in 1992 and progressed to third grade Multivariate regression analysis	Health status in both kindergarten and third grade Achievement scores	Measures of general and mental health status were significantly and independently associated with academic achievement scores in kindergarten and third grade.

## 6. Conclusions

This publication reviews the existing evidence of the potential impact of health behaviours and conditions on educational outcomes among children and adolescents in high-income countries. We had observed that most of the work documenting the no doubt close correlation between health and education in rich countries either assumed or tried to show that it was education that determines health rather than the reverse. However, extensive evidence from poor countries had documented the impact of health on education. We felt the imbalance was unjustified.

Fifty-three studies met our selection criteria. As the topic is potentially multidisciplinary, we specifically explored journals from multiple fields to minimise the risk of missing relevant research. Most of the work we found was published by public health researchers or economists. Although the amount of research is limited, interest has clearly been growing, especially since 2001.

While we cannot be sure to have exhausted the entire literature, the evidence we found provides overwhelming support for the relationship between childhood and adolescent health and educational outcomes. Overall, the studies reviewed found a negative correlation between risky health behaviours and (ill) health conditions on the one hand and, on the other, education as measured through both educational achievement and academic performance.

Important research challenges remain. We noted a geographical bias in the research, which has been mostly based in the United States and possibly driven by the availability of more appropriate data sources. This finding recommends the development of more data sets in European countries and the use of those data sets to further explore the likelihood that investments in health would lead to better educational outcomes.

In addition, despite growing, well-substantiated evidence of the causal link between health and education, more research adequately addressing methodological issues is required to verify a causal relationship between most of the health indicators considered and education.

Specifically, in the case of health behaviours, research is particularly scarce or less conclusive with regard to smoking and nutritional problems as compared to alcohol drinking and drug use. In addition and although an incipient body of literature points to a significant impact of physical exercise on academic performance, further research effectively establishing causality in this association is required. Concerning health conditions, research on the relationship between anxiety and depression (on the one hand) and children and adolescents' educational outcomes (on the other) remains particularly limited, especially considering the likely increasing relevance of these problems in industrialized countries.

Despite these limitations and gaps, the results of the literature review support our view that there are good reasons to believe that there is *also* a causal impact in high-income countries running from the selected health behaviours and conditions to education. This has important implications for how the health of children should be viewed in the general policy debate and for the ways in which we might consider improving educational outcomes in children and adolescents.

## Annex 1. Online databases used

### ScienceDirect

1. Advanced search
2. All sources
3. Terms [child health, children health, adolescent health, health outcomes]
4. AND [educational attainment, school achievement, academic performance, dropout, educational status]
5. All sources
6. Subject area [economics, econometrics and finance; medicine and dentistry; nursing and health professions; psychology; social sciences]
7. Dates: 1995 to present

### InterScience

1. Advanced search
2. Search for [health]
3. AND [academic performance]
4. AND [children]
5. Product type [Journal]
6. Subjects [All]
7. Date range between [1995 and 2008]
8. Order by [% match]

The option *related articles* allowed further restriction of the search.

### Scirus

1. All of the words [children, child, teenager, alcohol drinking, smoking, asthma, anxiety]
2. AND [educational status, educational attainment, academic performance]
3. AND [children, teenager]
4. Dates [1995–2008]
5. Only results in [all subject areas]

Each reading would allow searching similar studies through the *similar results* option.

### PubMed

1. MeSh Database
2. Search [asthma or sleep apnea, sleep deprivation, nutrition assessment, nutrition policy, child nutrition disorders, obesity, alcohol, drugs, smoking, depression, inattention, hyperactivity, anxiety, physical activity, exercise]
3. Send to search box with and
4. Clear search field
5. Search [education, cognitive development]
6. Send to search box with and
7. Select [educational status, learning disorders]
8. Clear search field
9. Search [children or adolescents]
10. Select [child or adolescent, adolescent behaviour, adolescent psychology, adolescent psychiatry]
11. Send to search box with and
12. Search PubMed

Key selected readings on the relevant topics in turn led to other related research and literature through the option *related readings* and the systematic review of cited references.

BioMed

Boolean search

Date from [1997 to 2008]

Queries:

1. health status AND (educational attainment)
2. children health AND (education)
3. children health AND academic performance
4. children health AND (academic performance)
5. children health AND educational attainment
6. children health AND (educational attainment)
7. children health AND (education level)
8. children chronic disease AND school achievement
9. children chronic disease AND grades
10. adolescence health AND academic performance
11. disease AND school achievement
12. asthma AND (academic performance)
13. obesity AND school achievement
14. adolescence health AND academic performance
15. adolescence health AND educational attainment
16. children asthma AND education
17. children asthma AND school
18. children asthma AND academic performance

The option *related articles* allowed to further restrict the search within each topic of interest.

Cochrane

1. Search for:
2. [Health outcomes]
3. AND [academic performance]
4. AND [children]
5. Date range: [1995–2008]

ISI Web of Knowledge

1. Search all databases
2. Topic [Health outcome or health status, asthma, sleep, alcohol, drugs, smoking, ADHD] AND [education or academic performance, academic achievement, educational attainment, educational outcomes, school] in topic
3. AND [children or adolescent, adolescence, young adult, teenager] in topic
4. Limit to [latest 5 years]

Again the key papers helped restrict the search through the option *view related records* and the review of main references.

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## The WHO Regional Office for Europe

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Europe is one of six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

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More often than not, the undoubtedly close association between health and education is interpreted or even shown to represent a causal effect running from education to health, especially in high-income countries. This publication explores, specifically in high-income countries, the extent to which a causal link may also run the other way, from health to education. That is, to what extent do good health and healthy behaviours contribute to educational attainment? We start with the hypothesis that this direction of the relationship has been somewhat ignored both in research and, arguably, in the public policy debate. While the health challenges children face in rich countries likely affect education less than the more life-threatening health challenges in poor countries, a potentially relevant effect of health on education in the industrialized world cannot be automatically ruled out. This publication aims to review the current knowledge of the effect that different health conditions and health behaviours in children and adolescents can have on educational outcomes in the context of rich countries.

As it turns out, although these questions have not been a major research focus, the evidence that does exist offers a lot to suggest a causal contribution of health and health behaviours to various educational outcomes. While gaps in the research remain, its results already bear relevant policy implications both for the wider importance of child health in rich countries (extending beyond the health benefits per se) and, hence, for the ways in which educational outcomes might be improved.



**World Health Organization Regional Office for Europe**

Scherfigsvej 8, DK-2100 Copenhagen Ø, Denmark

Tel.: +45 39 17 17 17. Fax: +45 39 17 18 18. E-mail: [postmaster@euro.who.int](mailto:postmaster@euro.who.int)

Web site: [www.euro.who.int](http://www.euro.who.int)