# Effects of Finnish comprehensive school reform on gender and socioeconomic inequalities in mortality and hospital utilization

Master of Health Economics thesis
Hannu Vessari
hannu.vessari@student.eur.nl
Prof. Eddy van Doorslaer
Institute of Health Policy & Management
Erasmus University Rotterdam

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## Abstract

As part of building Nordic welfare state, Finland adopted a comprehensive school reform between years 1972 and 1977. The main change in the reform was the increase of school tracking age of children from 10-11 years of age to 15-16 years of age. The reform was passed through the country region by region starting from northern Finland and spreading towards south. This made it possible to examine the effects of the reform on health in a quasi-experimental setting. By combining Finnish Longitudinal Census data and National Hospital Discharge records, the effects of the reform on all-cause mortality analysed with Cox regression and hospital utilization with negative binomial regressions. Explanatory variables included exposure to the reform, sex, birth cohort, region, and adolescence socioeconomic status indicators (father's education and parental income). The main findings are that the comprehensive school reform may have had a pro-female effect on mortality between sexes, which suggests that the reform should have increased the life expectancy gap between genders. As such, it does not help to explain the observed reduction in differences between period life expectancies between males and females after 1978. Secondly, the reform didn't have a significant effect of socioeconomic distribution of health measured by mortality and hospital utilization. Third, parental income is associated adulthood mortality and hospital utilization regardless the socioeconomic status in adulthood. And finally fourth, the comprehensive school reform reduced the association of parental income on number of hospital admissions especially among lower socioeconomic groups, and reduced the importance of father's education on hospital admissions within lowest educational group.

## Introduction

The link between socioeconomic status and health has been well established in numerous countries and with various sets of material and methods: Individuals belonging to higher socioeconomic classes, whether measured with income, education or other measures of socioeconomic status, seem to have better health status, also measured with various different indicators (National Center for Health Statistics 2012, Wikström et al. 2011, Schafer et al. 2012, Palosuo et al. 2009). Monitoring of health inequalities between different socioeconomic groups has also become more regular, and even systematic activity in many countries (Palosuo et al. 2009, National Center for Health Statistics 2012), including Finland.

Although the association between education and health is very well known, there still are substantial knowledge gaps. First, the mechanisms are still poorly understood. One reason for this is the difficulties in measuring health in simple way: Different indicators of health describe different aspects of the multidimensional nature of individual and population health status. Another reason is that causality and mechanisms between education and different aspects of health may vary between communities and over time, making them more difficult to uncover. Measuring education is not simple either. Typical measurement of education is the number of years of schooling or the level of educational degree acquired. But also education has its quality aspect, which is more difficult to measure: It may be dependent on for example the level of education of the teacher, the content of the curriculum, the number of pupils in one class or the age when schooling starts or pupils are tracked in different schools. There are some studies, which have investigated the quality aspects of schooling on health(Jones et al. 2010, Fletcher, Frisvold 2012). Another piece of missing information is that there is only limited information about the impact of methods and policies which have been used to reduce the socioeconomic health inequalities (Palosuo et al. 2007).

In the past few years the Finnish educational system has received a lot of attention for two very different reasons: On one side the good performance in OECD Programme for International Student Assessment, or PISA (Simola 2005, Sahlberg 2007, OECD 2011) has increased international interest in Finnish comprehensive school system. On the other hand two unfortunate events of school shootings in Finland within just one year in 2010 and 2011 have highlighted the question on children and adolescent well-being and mental health and school system's role in them. While PISA is measuring outcomes in skills and knowledge on a population level within school, it doesn't provide any information about other outcomes of education. Such outcomes of interest from societal perspective would be for example employment and unemployment rates, income level and distribution and various public health measures. Some of these outcomes have already been investigated by other

studies. These studies suggest that the comprehensive school reform in Finland would have increased gender differences in higher education attainment and decreased gender wage gap (Pekkarinen 2008), increased intergenerational income mobility (Pekkarinen, Uusitalo & Kerr 2009) and inreased the use of library services especially among the lowest socioeconomic groups but with significant geographical variation (Mäkinen 2010). No studies with public health outcomes have been published with Finnish data. One study with similar setting in Sweden has been published by Lager and Torssander (2012). They studied the effects of Swedish school reform on mortality. In their sample which comprised almost entire Swedish population born between 1943-1955, they found statistically significant, but rather small reduction in mortality (4% reduction in all-cause mortality hazard ratio) among those who had been exposed to the school reform. The comprehensive school reform in Sweden has many similar aspects as the reform in Finland 23 years later, so it will act as a good comparator for results.

Another point of interest in Finland is the socioeconomic differences in health. Finland, as well as other Nordic countries, is considered to have relatively small socioeconomic differences, especially regarding income differences. Finland has, however, rather high socioeconomic health differences (Palosuo et al. 2007, Tarkiainen et al. 2012, van Doorslaer E., Masseria C. & OECD Health Equity Research Group 2004, Mackenbach et al. 2008) as well as differences in health care use (van Doorslaer E., Masseria C. & OECD Health Equity Research Group 2004, Palosuo et al. 2007, Devaux, de Looper 2012), as we will see later in this thesis. The comprehensive school reform has typically been seen as a policy to increase equality in society (Pekkarinen, Uusitalo & Kerr 2009), but so far its effects have not been assessed regarding socioeconomic health differences. Some earlier studies also show that socioeconomic status may have long-term impacts on health: A study in Sweden suggests that parental income level is negatively correlated with mortality also later in life (Palme, Sandgren 2008), and similar results have also been seen with other socioeconomic status indicators and health outcomes (Jones et al. 2010).

So, studying the effects of this school reform is interesting for two reasons: First, it can provide us with some information about the importance and mechanisms of basic level education on different aspects of health; Second, it can also give some information about the value of certain type of schooling reforms as means of reducing socioeconomic inequalities in health.

The purpose of this study is to examine the effects of the comprehensive school reform on hospital admissions and mortality, as well as its impact on socioeconomic family background as a determinant of hospital admissions and mortality. The first part reviews some of the earlier research on

socioeconomic health inequalities in Finland. The second part will briefly describe the comprehensive school reform in Finland. In the third part, the description of the material and methods used will be given. The fourth part will present the results of this study, and the fifth part will conclude the paper.

## Socioeconomic health differences in Finland

Finland has a long tradition of studying health inequalities. Countrywide population statitics have been available since 1749, which has made it possible to study regional diffenrences in mortality. Although good quality data about socioeconomic statuses is not available for the same period, it is known that before the Second World War, the correlation between regions and income and wealth was considerably higher than later towards the end of 20th century. This gradient in socioconomic distribution between regions can also be considered as one of the driving factors of regional health differences in those days. (Palosuo et al. 2006, Pitkänen, Koskinen & Martelin 2000). The aim of reducing regional inequalities in wealth, education and health has been one of the arguments for many policies in education, labour markets and social and health care sectors. These measures have also proven efficient at least to some extent: Regional differences in all these three sectors have been decreasing, although differences still exist. (Pitkänen, Koskinen & Martelin 2000). For example, life expectancy at birth between 2004 and 2007 was highest in Pohjanmaa region, 81 years and lowest in Kainuu region, 77,4 years (National Institute for Health and Welfare).

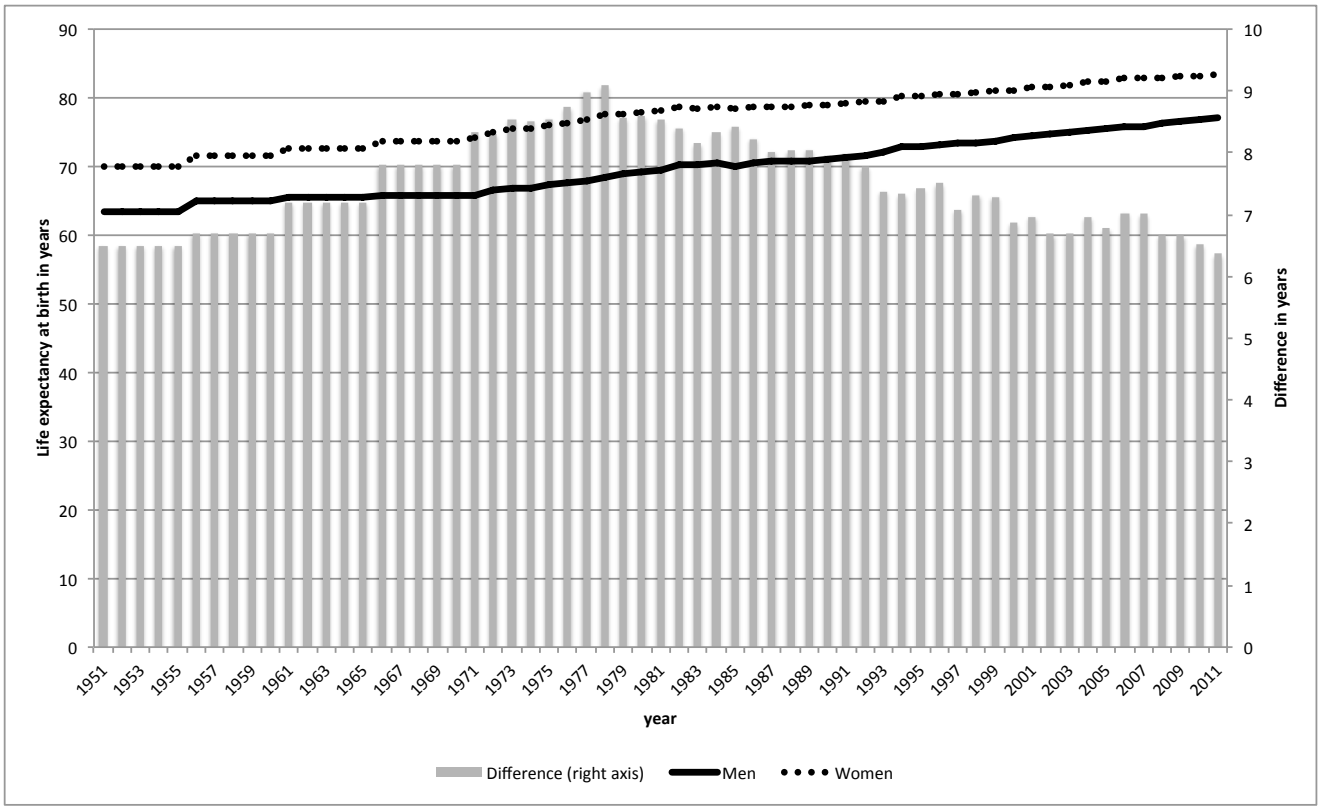
Health inequalities specifically between different socioeconomic groups have been studied more systematically after the publication of the Black Report in 1980 (Palosuo et al. 2007). Since 1986, working towards more equal distribution of health has been part of health and health care policies in Finland (Palosuo et al. 2006).

This chapter looks briefly into previously published information about health inequalities between different educational groups with different indicators. Mainly the focus will be in mortality differences and their trends.

### Life expectancy

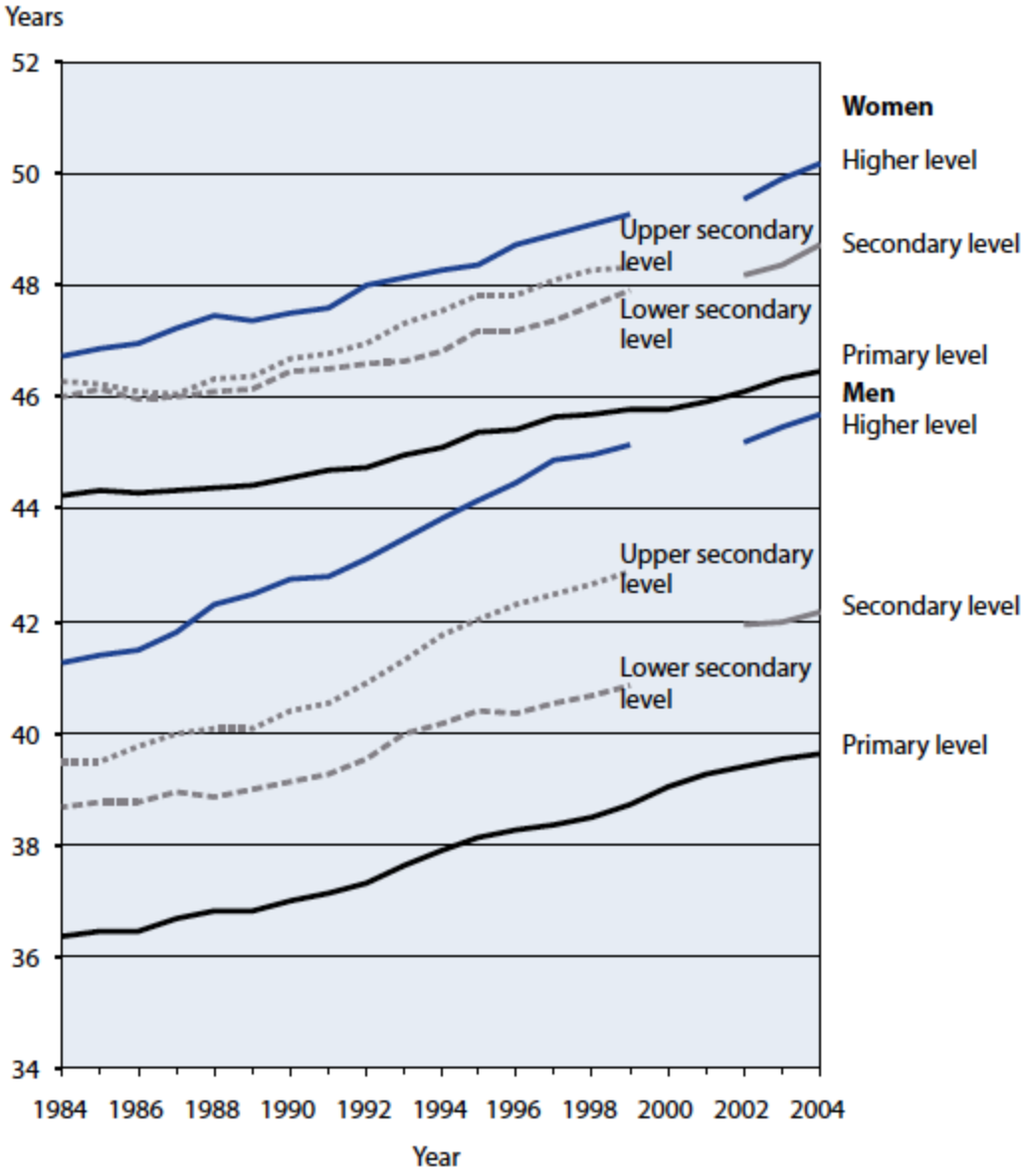
The longest tradition on health inequalities investigations is in mortality differences between different educational and occupational groups, which have been studied by Helsinki University sociology department together with Statistics Finland since the early 1980s. The reason for this is probably good quality information that has been available about educational and occupational background as well as mortality, and personal identification number system which has made it possible to combine information from different sources for the whole Finnish population. The typical way to show concisely the information about mortality is to calculate life expectancy for different groups of people.

The graph 1 show the trends of life expectancy at birth for males and females. The bars indicate the difference and shows that there has been an increasing trend until 1978, after which the trend has been decreasing. In 1978 the difference in life expectancy at birth was 9.08 years and in 2011 6.36 years.



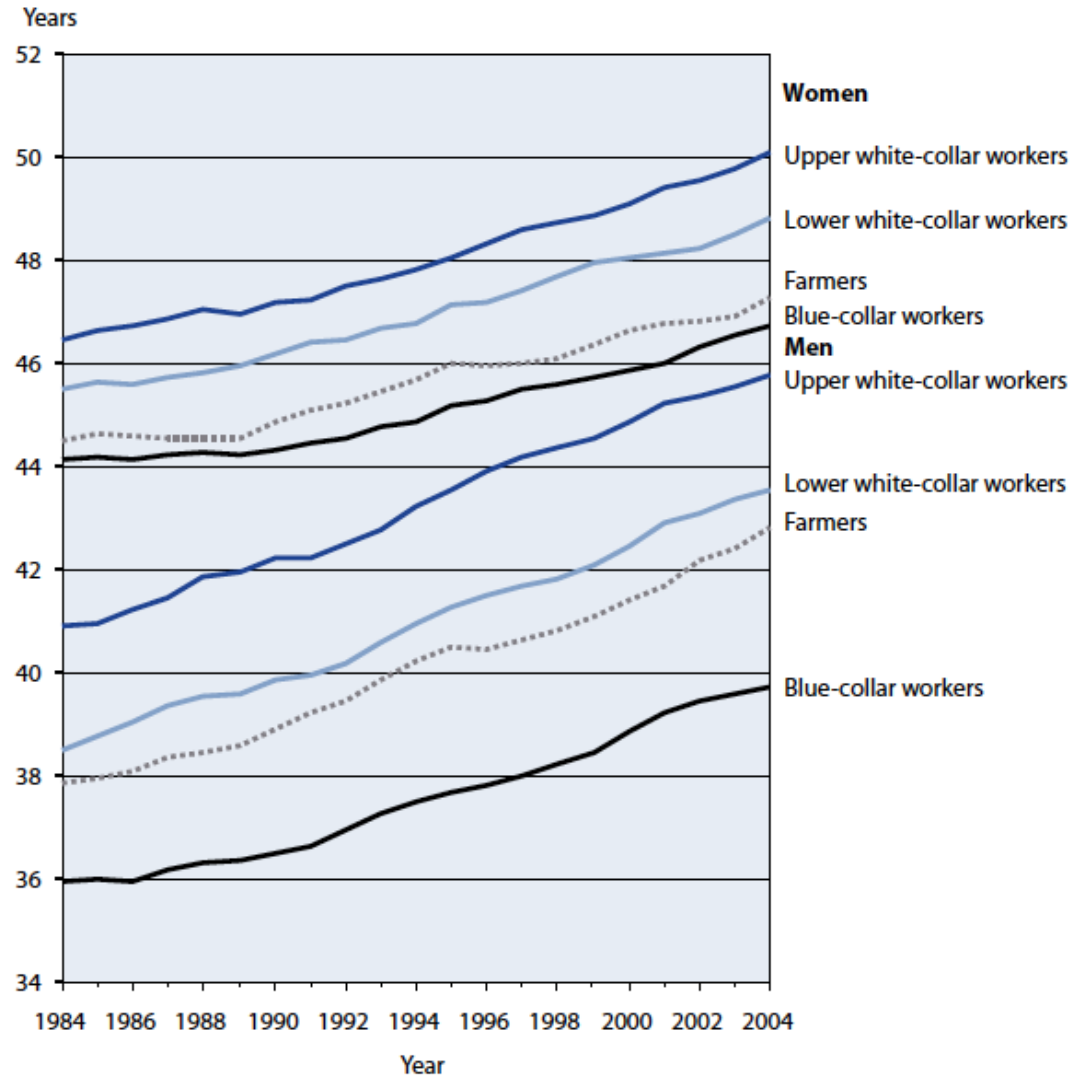

**Graph 1: Life expectancy at birth by sex between 1951 and 2011. Before 1971 life expectancies have only been reported for 5-year periods (Statistics Finland 2012).**

The graph 2 shows the trends of differences in life expextancy at the age of 35 years by sex and educational level. The latest years are not fully comparable with earlier years, since educational categorization was changed in 1997, and within this change, only the lowest educational category remained unchanged. Most of the earlier upper secondary level educational institutions were classified into higher level education, which can be seen in the graphs as small downward offset in the trendlines. Before the change, the difference between primary level and higher education level groups was slowly increasing among both sexes. The differences between corresponding educational groups between sexes have been decreasing. For example, with only primary level education the difference between males and females has decreased from 7,8 years to 7,2 years, and with higher education from 5,8 years to 4,4 years. Also, the mortality difference between highest and lowest educational groups among males is about 2,2 years bigger than among females (Palosuo et al. 2006).




**Graph 2: Life expectancy at the age 35 by sex and level of education between 1984 and 2004 (Palosuo et al. 2009).**

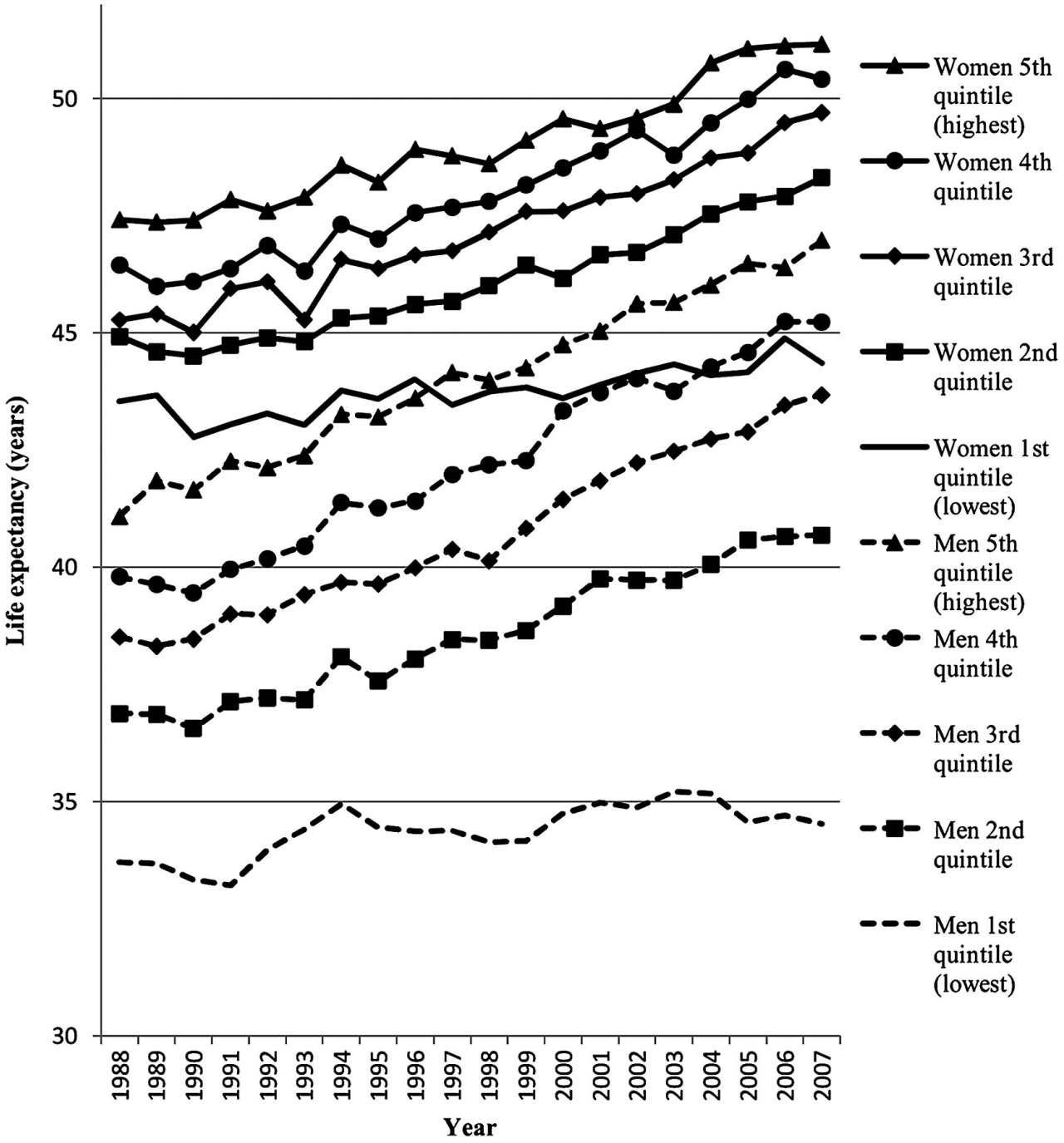
The studies are using the occupational position classification of Statistics Finland, which classifies different occupations in 4 different categories. The picture is very similar to trendlines in different educational classes, with steadily increasing trend. No evident changes in trends have happened during 20 years of data. Also the relative differences between groups have maintained rather steady. With occupational classification, the differences between the worst-of and best-of groups are slightly smaller than between highest and lowest educational groups among both sexes. Similarly as with educational groups, the differences between corresponding occupational groups between sexes have been decreasing. Among blue-collar workers the difference between sexes has decreased from 8,1 years to 7,0 years and among upper white-collar workers from 5,4 years to 4,2 years (Palosuo et al. 2006).




**Graph 3: Life expectancy in at the age of 35 by gender and occupational position in Finland between 1984 and 2004. (Palosuo et al. 2009)**

The development in mortality differences looks slightly different when using income as indicator for socioeconomic status. This has been been recently studied with the same dataset that this study is using by Tarkiainen, Martikainen, Laaksonen and Valkonen (2012). Graph 4 shows the development of life expectancy at the age of 35 years in different income groups and by sex. The immediate finding from the graph is that among both sexes, the increase of life expectancy in the lowest income quintile has been almost in stagnation between 1988 and 2007. During this period the gap in life expectancy between the highest and the lowest income quintiles grew by 5.1 years among males and 2.9 years among females. While the difference in trends compared to results with other socioeconomic indicators may arise from importance of economic resources on health, it is also possible that the results are to some extent biased due to selection. The lowest income quintile may contain more individuals with poor health, or individuals who have died at early stage of year maybe may fall to poorest quintile even they would belong to wealthier quintiles if they had received full year's earnings. This type of downward shift in ranking is more likely to happen with people with high income, and

thus those who are still relatively young to die, having more impact on period life expectancy.




**Graph 4: Life expectancy at the age of 35 years by sex and income quintiles between 1988 and 2007 (Tarkiainen et al. 2012).**

The same group also investigated the contribution of different causes of deaths on the widening of the differences between highest and lowest income quintiles. One third of the differences were due to alcohol-related causes of death, 19% to ischemic hearth disease, 14% to various cancers and 11% to accidents and violence. Within these four causes of death, differences in ischemic heart disease mortality was mainly among people over 65 years age, but for the other three among population between 35 and 64 years of age (Tarkiainen et al. 2012).

## Socioeconomic differences in health behaviour

There are also studies with Finnish datasets that try to find reasons behind the differences. These studies are mostly based on regularly performed surveys, which collect information about different health-related aspects, such as smoking, alcohol consumption, dietary habits and physical activity. These studies mostly use educational attainment as the socioeconomic indicator, but also income is used in some of them.

National Institute for Welfare and Health gather information about health and health behaviour of adult population with an annual mail survey, which results are published the following year. This survey also collects information about educational background of the sample population. The latest published report shows the trends in tobacco smoking by different educational groups between years 1978 and 2011. For men, the proportion of daily smokers has been steadily decreasing is each educational tertile, but the decrease has been faster in higher educational groups, increasing the difference between groups. For women, only among the highest educational tertile has the proportion of daily smokers decreased, when in the lowest tertile the proportion has increased, again increasing the differences. The lowest tertily has 3 times higher proportion of daily smokers than highest tertile among both sexes (Helakorpi et al. 2012). The differences in smoking behavior have long been considered as a major reason for socioeconomic health differences (Pekkanen et al. 1995).

Similar differences have been found regarding nutrition. There are significant differences between educational groups in healthy eating habits (Helakorpi et al. 2012), in the consumption of saturated fats (Palosuo et al. 2007) and vegetables (Helakorpi et al. 2012). Unlike in smoking, these differences have remained rather constant, except in the consumption of saturated fats, in which the differences have been decreasing.

There are also differences in alcohol consumption between different socioeconomic groups. The trends in alcohol consumption have been quite similar in different socioeconomic groups: There is a gradual increase in indicators of alcohol consumption between 1982 and 2005 in each educational group, and after that the consumption has stabilised. A marked difference, however, was noticed in 2004, when the consumption in lowest educational tertile increased significantly more than in other socioeconomic groups, and subsequently the consumption in this group has stayed on a higher level (Helakorpi et al. 2012). The probable reason for this change is the alcohol tax rebate in 2004, which lowered the prices of alcoholic beverages. In 2011 the differences between educational tertiles was very small: About 40% of men in each group have drank at least 8 alcohol units in the past week, and

among women about 30%, regardless the educational group, have drank at least 5 alcohol units in the past week (Helakorpi et al. 2012).

The trends in leisure time physical activity show very similar increase in every educational tertile for both sexes. Among women the educational tertile differences have been very small between 1978 and 2011. The share of women pursueing leisure time physical activities has increase during this period from 40% to 70%. Among men, there is a similar increasing trend, but there also is a small and constant gradient between different educational groups: The share of those excericising at least 2 times a week has increased 45% to 70%, while the same increase in the lowest tertile has been from 40% to 60% (Helakorpi et al. 2012).

### Utilization of health services

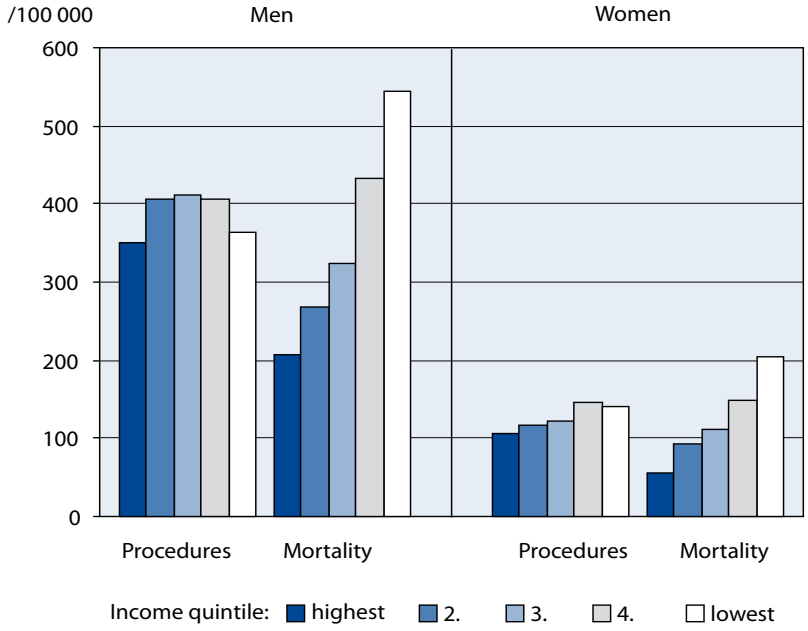
Socioeconomic differences in utilization of health care services has also been studied in Finnish setting, but the scientific information is less abundant compared to differences in mortality or health behaviour.

The difficulty when assessing the use of services is to tackle the problem of heterogeneity in the need of services between different individuals. There are various methods which try to estimate the need of services by using different factors, such as age, gender, chronic morbidity and self-assessed health status. By estimating the need of services for different indiduals, the use of services can be adjusted by need to show if other factors might be driving the differences in service use.

The income related distribution of health services according to the need is typically measured with horizontal inequity index, which can have values between -1 and 1. Positive indeces mean need-adjusted distribution of services which is concentrated towards richer individuals and negative towards the poorer ones. According to group of Finnish experts the income-related inequity in the need-adjusted service use has slightly decreased between 1987 and 2000 (The horizontal inequity index changed from 0.07 to 0.04 in all medical visits). The changes were, however, not statistically significant (Palosuo et al. 2007). Similar results were published in 21 OECD country comparison in 2004, Finland had one of the highest horizontal inequity index among examined countries, 0.073 in all medical visits (van Doorslaer E., Masseria C. & OECD Health Equity Research Group 2004). There are differences between different types of health services. When examining out-patients visits, in 2000, the visits to a health centre were concentrated towards the poor (Horizontal inequity index -0.08, $p<0.01$), when out-patient visits in occupational health care and private clinics were concentrated towards rich (0.25, $p<0.01$ and 0.17, $p<0.01$, respectively). Most of the visits to private

clinics are to care provided by specialist. Within the out-patient visits in the hospitals there were no significant income-related inequality (0.01, not statistically significant) (Palosuo et al. 2007).

When it comes to hospital services, the use of services overall is concentrated towards the poor, which corresponds to information about morbidity. However, there is evidence that level of use of services don't go along with the level of need. Most abundant amount of scientific evidence is about socioeconomic difference in the treatment of coronary heart disease (CHD). According to some studies, the socioeconomic differences in CHD procedures have been decreasing between 1988 and 1996 (Hetemaa et al. 2003), but the differences still remain. No later publications were found on this issue. Graph 5 shows the differences between CHD-related procedures and the need of the procedures presented by CHD mortality.




**Graph 5: Coronary artery procedures (angioplasty and bypass crafting) and coronary heart disease mortality by income and gender in the Finnish population aged 25-84 per 100000 population in 2003 (Palosuo et al. 2009).**

Similar findings about unequal socioeconomic distribution of procedures have also been shown with other procedures, but without need-adjustment. A research group based in National Research and Development Centre for Welfare and Health has shown persistent pro-rich distributions in lumbar disc operations and primary knee replacements among males between 25-84 years and in lumbar disc operations and hysterectomies among the same aged women between 1992 and 2003 (Manderbacka et al. 2009).

## Summary

This part did not try to be an exhaustive review on the existing scientific information on socioeconomic differences on health, but to provide a quick look into observed socioeconomic health differences and into known reasons behind them. To summarize, the inequalities in mortality between different socioeconomic classes seem very consistent within the past three decades, regardless the indicator used for defining socioeconomic status. The biggest differences are between different income quintiles, and the increase in mortality difference between lowest and highest socioeconomic groups is most evident between 1987 and 2007. There are differences in several health behavioral factors, especially in smoking, which can explain these differences. Also, the health services are more accessible for higher socioeconomic groups. Gender differences in mortality have been steadily decreasing since 1978.

Another distinct feature in Finnish studies about health inequalities is that there are mostly descriptive. Systemic analysis of effects of policy changes have not been done, so there's very little evidence-based knowledge about the effectiveness of different interventions.

## The Finnish comprehensive school as a quasi-experiment

To study the mechanisms between education and health, this study is taking advantage of the comprehensive school reform. As a part of building a Nordic type welfare state, Finland adopted a comprehensive school reform in the years between 1972 and 1977. The aim of the reform was to provide equal chances for children with different socioeconomic backgrounds to acquire schooling, and through this, deminish socioeconomic disparities. Although the details of the reform have been thoroughly described from different perspectives in various publications (Somerkivi 1982, Simola 2005, Sahlberg 2007, Kivirauma, Ruoho 2007, Pekkarinen 2008, Pekkarinen, Uusitalo & Kerr 2009, Mäkinen 2010), a brief description of the main aspects of the reform is provided below. Important feature in the reform was that it was implemented in six consecutive years in different regions of the country, allowing it to be used as a quasi-experiment setting to examine how education may effect on health.

### The description of Finnish comprehensive school reform in 1972-1977

The comprehensive school reform had two main impacts on Finnish education system: From pupils perspective, the age of the school tracking was postponed significantly from 10-11 years to 15-16 years of age. Also, in some municipalities, mandatory schooling years increased from 8 to 9 years. From municipalities' and teachers' perspective the ownership of the majority of upper-secondary schools was changed from private to public ownership. Both of these changes came into force at the same time.

Before the reform, the children started schooling at the age of 7 with common 4 years of primary school. Then they were tracked at the age of 10 or 11 years into general secondary school for the next 5 years, or into continueing for 2 more years in primary school and then continue for 2-3 years in civic school. The tracking to general secondary school was based on entrance examinations, school performance and primary school teacher's assessment. There was local variation in the length of the civic school from 2-3 years. No centralised record is available about the lenght of civic schools in different municipalities. Studying in the general secondary school typically led to upper-secondary school and matriculation examination, which served as an entry requirement for university studies when primary/civic school track typically led to vocational school or directly to employment in different fields of manual labour.

After the reform every child was subjected to nine years of uniform comprehensive school and the tracking into different mid-level education tracks was done at the age of 15 or 16 years, which postponed the school tracking by 5 years. Entry to secondary education is based on the school

performance in the comprehensive school. To make it possible to incorporate pupils from general secondary schools and primary/civic schools together in five last classes of comprehensive school the academic content was made less theoretical compared to general secondary school level. The comprehensive school system is still the existing one in Finland. Figure 1 has a simplified schematic illustration of the school tracking before and after the reform.

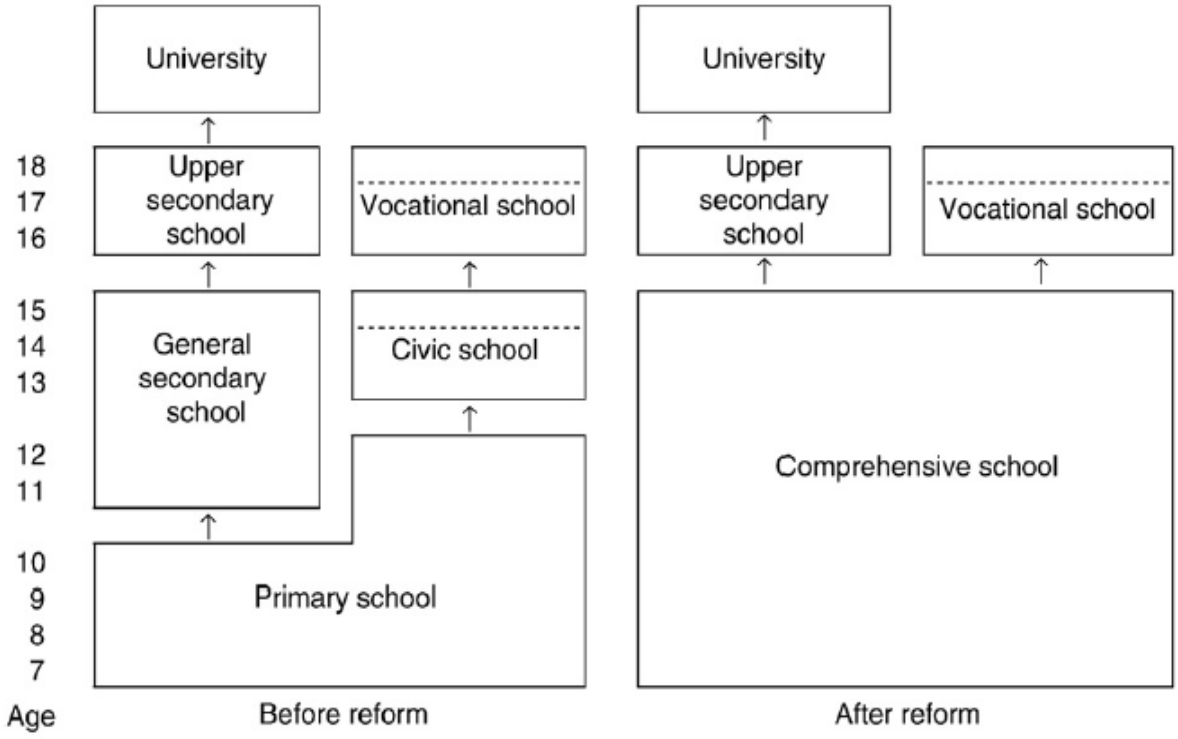



**Figure 1: Finnish school system before and after the comprehensive school reform (Pekkarinen 2008).**

The other aspect of the comprehensive school reform affected the ownership of the secondary schools. Before the reform most, about 55% of the secondary school students went to privately owned schools, about 30% to state owned schools and the rest 15% to municipality owned schools. All secondary schools were obliged to follow common national curriculum. Privately owned secondary schools did collect tuition payments, but they received most of their funding from the state and local municipalities, similarly as publicly owned schools. Within the reform, most of the private secondary schools were converted into publicly owned upper-secondary schools without tuition payments, with some exceptions on the secondary schools having long traditions. The purpose of this part of the reform was to provide equal access to secondary level education in every part of the country and to prevent development of elite schools, a feature which was considered important for equality.

Before the reform there was geographical variation especially in the provision of civic school. The political decision for the policy change had already been done in 1968, due to which some

adjustments to the schooling system had already been made before the actual reform (Jauhiainen 2002). One example of these was voluntary extension of civic school length from 2 to 3 years, which extended the basic level schooling to 9 years also among those who didn't go into general secondary school or aim to higher education. Due to this, within the reform the mandatory schooling years increased by one year for some pupils, but for pupils in some municipalities there was no change.

### The implementation of the reform

The reform was implemented within 6 consecutive years starting in 1972 in municipalies in northmost region called Lapland as well as some municipalities in other regions of Finland. The process of how municipalities outside Lapland were chosen to have the reform earlier is not known. In the following years the reform then spread from Northern Finland towards south, reaching the Southern Finland municipalities, including the capital city Helsinki by 1977. Each year the children who started their class from one to five were adopted in comprehensive school, and those starting a higher class level continued in the old schooling system. The figure 2 shows in details the timing of the reform indifferent municipalities.

Just by looking at the map in figure 2 it is rather clear that the implementation of the reform was not random, but correlated with the some socioeconomic factors. The wealthier parts of the country are located in the south and on the western coast, which were the regions affected latest to the reform. This is also shown in the graph 6. Also, the southern parts of the country were known to have more people with higher education. This is true also in our dataset, shown in the graph 7. Also, when it comes to health indicitors, there are also known regional differences: As mentioned earlier, life expectancy at birth varies by region, increasing from north to south and from east to west. Between 2004 and 2007 life expectancy at birth was highest in Pohjanmaa region (western coast area), 81 years, and lowest in Kainuu region (north-eastern region), 77.4 years (Statistics Finland 2012). Due to these regional differences it is important to control the region when analyzing the effects of the reform.

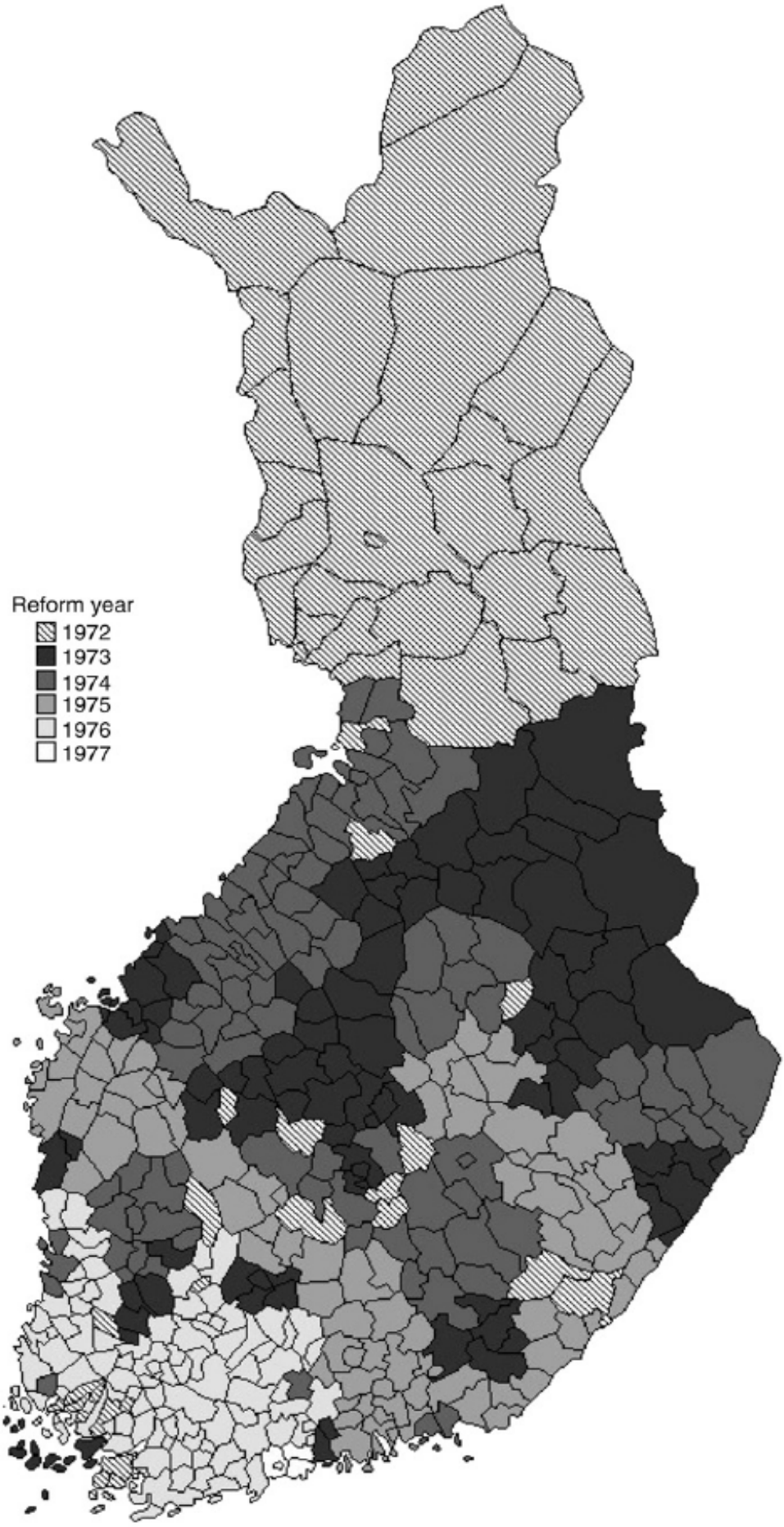
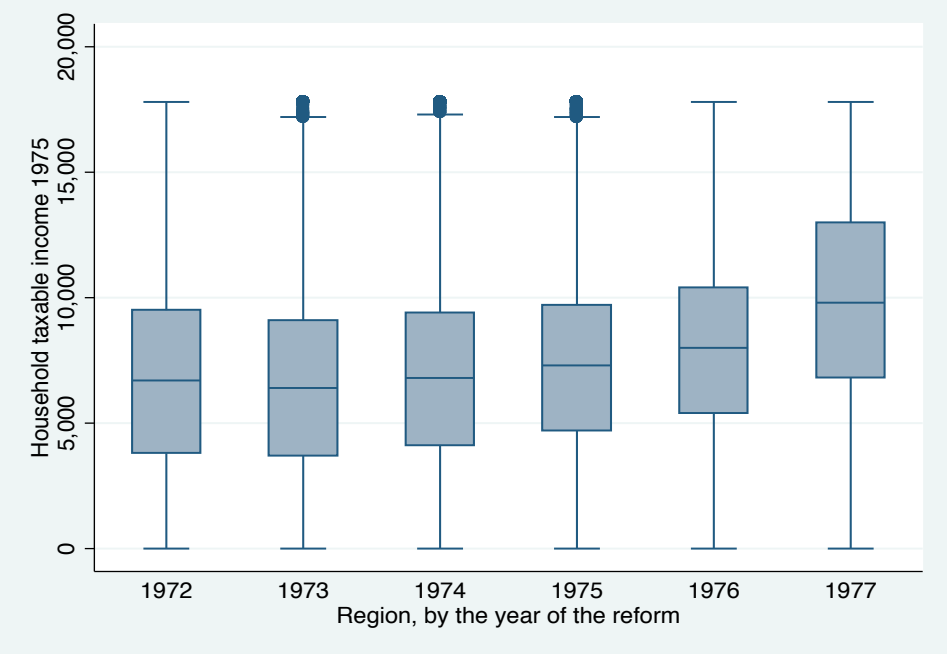
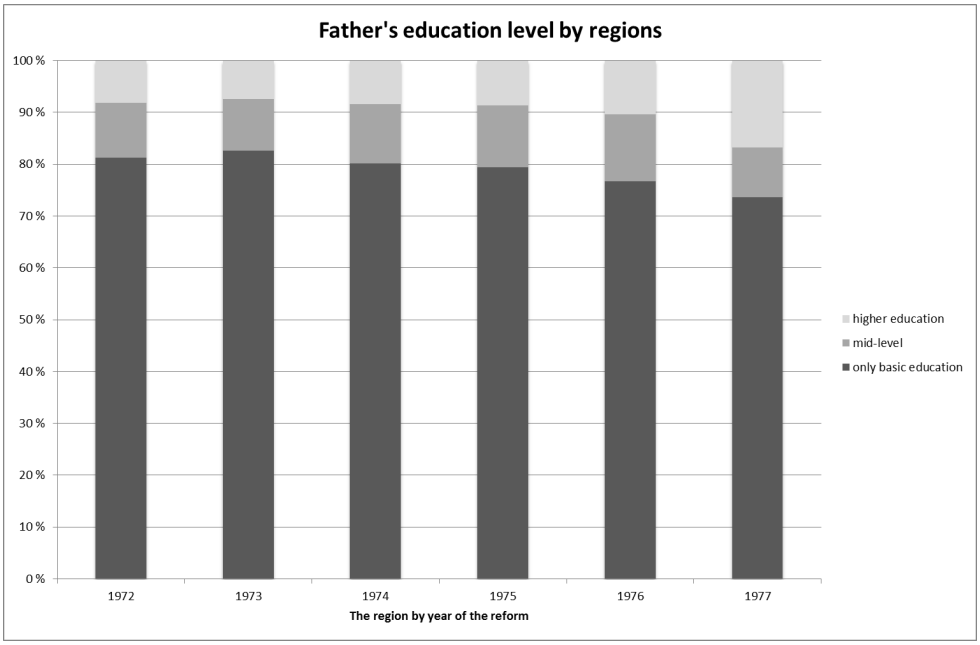



**Figure 2: The timing of the implementation of the comprenhensive school reform in Finland (Pekkarinen 2008).**




**Graph 6: Parental taxable income in 1975 in the study population by the regions used in the comprehensive school reform.**




**Graph 7: Father's education level in the study population by the regions used in the comprehensive school reform.**

## Earlier studies about impacts of the comprehensive school reform

The impacts of the reform have been studied earlier in a similar quasi-experimental setting, but not within the context of health outcomes. I will here briefly present the earlier findings.

One of the main arguments for the comprensive school reform was to provide everybody an equal opportunity to acquire education regardless the place of residence or social background. Pekkarinen, Uusitalo and Kerr have been investigating these aspects. First, they have examined the impact of the reform on equality of opportunities. One way to assess this is through intergenerational income mobility, that is, how strongly the income level of the previous generation effects on the income level of the present generation. They found that the comprehensive school reform reduced intergenerational income elasticity by 23% from pre-reform level of 0.30 to post-reform level of 0.23. They also found out that father-son income elasticity was stronger than father-daughter income elasticity, and the impact of the reform on reducing the elasticity was not significant for father-daughter income elasticity. Their finding thus suggests that the reform would have stronger impact on boys, but they also acknowledge that this result may well be biased due to the fact that the income of daughters' were observed in the age of 30 to 40, and their income may be affected by raising of small children (Pekkarinen, Uusitalo & Kerr 2009).

Another study by Pekkarinen examined the impact of the reform on educational attainment and individual income level. The results suggest that the reform increased the probability of acquiring higher education more among females than among males. Similar finding was made with individual income level in 2000. Also, both of these effects were stronger among those who came from the families where father had academic education. Thus, the reform seems to have increased the difference in attainment on higher education and decreased the differences in wages between sexes. The study also tries to differentiate, whether these effects are more due to changes in the curriculum, or due to change in the tracking age. If effects of the curriculum change are considered to be cumulative (the more exposure to the new comprehensive school curriculum, the more effect) and the effects of the change in school tracking age immediate, then the effects to higher education attainment seem to come from change in school tracking regime (Pekkarinen 2008).

The same researchers have also investigated the effects of the reform to cognitive skills by combining the census data to Finnish Army basic skills test results. Analysing these test scores, they found that individuals whose parents had only basic level education improved their mean scores in verbal skills and mathematical and logical reasoning, but overall the reform had small beneficial effect only on mean scores on verbal skills, but no significant effects on other tests. No effect was seen in the variation of the scores. Due to the nature of the outcome variable, this study only describes effects of the reform among males, and thus doesn't provide explonations to the effects found in other studies (Pekkarinen, Uusitalo & Pekkala Kerr Sari 2009).

So far there isn’t any publications about effects of the comprehensive school reform on health outcomes.

## Material and Methods

The material for this study was collected from three different Finnish administrational registries. The first registry is Finnish Longitudinal Census, and it is administrated by Statistics Finland. It contains information about main type of activity of the population, household composition, occupational status, educational level and income of the population from 1970 onwards. The second registry is national causes of death, which contains data of on deaths and mortality by cause of death, age, gender, marital status and other demographic variables, as well as some information about circumstances of deaths. The third registry used in this study, from which the health outcome variables are derived, is the Hospital Discharge Registry, which contains the dates of hospital inpatient care, and the diagnosis associated for each stay. This registry is administrated by National Institute on Welfare and Health and it covers all the public hospitals in Finland. The information from these three registries was linked by using the personal identification number.

A random sample of 11% was taken from birth cohorts between years 1960 and 1966. The birth cohorts were chosen so that out of the first cohort, that is 1960 birth cohort, none was exposed to the reform, and in the 1966 birth cohort everyone was exposed to the reform. Within the birth cohorts from 1961 to 1965 there were an increasing proportion of children who were exposed to to the reform. Table 1 describes the sample by birth cohorts and by reform regions, and shows which groups were exposed to the reform. The exposure to the reform was coded by Statistics Finland. An individual was coded to be affected by the reform, if he or she lived in the municipality in the year when that municipality adopted the reform. Because people might have moved from one region to another, this can lead to some misclassification, but the importance of this is likely to be small.

| | | Regions with reform in | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1972 | | 1973 | | 1974 | | 1975 | | 1976 | | 1977 | | |
| | | boys | girls | boys | girls | boys | girls | boys | girls | boys | girls | boys | girls | Total |
| Birth cohort | 1960 | 418 | 387 | 558 | 657 | 872 | 880 | 896 | 836 | 877 | 854 | 515 | 507 | 8257 |
| | 1961 | 437 | 427 | 599 | 611 | 846 | 882 | 858 | 823 | 909 | 887 | 497 | 491 | 8267 |
| | 1962 | 406 | 401 | 637 | 604 | 845 | 847 | 849 | 817 | 914 | 891 | 499 | 524 | 8234 |
| | 1963 | 425 | 381 | 587 | 581 | 798 | 853 | 891 | 841 | 955 | 923 | 536 | 524 | 8295 |
| | 1964 | 392 | 359 | 628 | 570 | 807 | 811 | 869 | 870 | 915 | 878 | 566 | 560 | 8225 |
| | 1965 | 375 | 356 | 579 | 525 | 751 | 818 | 861 | 855 | 880 | 843 | 584 | 563 | 7990 |
| | 1966 | 379 | 345 | 539 | 548 | 777 | 789 | 815 | 812 | 947 | 899 | 580 | 534 | 7964 |
| | Total | 2832 | 2656 | 4127 | 4096 | 5696 | 5880 | 6039 | 5854 | 6397 | 6175 | 3777 | 3703 | 57232 |

| | Total | Boys | Girls |
|---|---|---|---|
| Individuals not exposed to reform | 30582 | 15399 | 15183 |
| Individuals exposed to reform | 26650 | 13469 | 13181 |
| | 57232 | 28868 | 28364 |

**Table 1: The study population by gender, birth cohorts and the reform regions.**

For the protection of the privacy of the individuals within the sample, the process of combining the registries was carried out by Statistics Finland, and all personal identity numbers were replaced by a research ID number. Permission for the study was acquired from both registry authorities. The permission code for the study is TK-53-1519-09.

Within this study, two different measures of hospital utilization after the age 27 years are used as outcome measure for health, namely the number of admissions and the number of days spent in the hospital.

### The econometric model

The econometric model used takes advantage of the way the comprehensive school reform was implemented in Finland. At the same time in different municipalities, there were children going to school in both school systems. Also, the children couldn't choose themselves whether they would go to primary school or comprehensive school. This type of implementation enables to compare different outcomes of the children who are exposed to the reform to outcomes of those, who are of the same birth cohort but not exposed to the reform. This is usually called as difference-in-difference model, or quasi-experiment.

To estimate the effects of the comprehensive school reform and socioeconomic background on mortality and different hospital utilization outcomes ($H$) the following model is used:

$$H = \alpha + \beta R_{jt} + \gamma_0 B + \gamma_1 B * R_{jt} + \delta_0 X + \varepsilon$$

In the model $R_{jt}$ is a dummy-variable stating if region $j$ has adopted the reform at year $t$, $B$ is a variable describing the socioeconomic background of the individual, $X$ is a vector of other control variables. $B$ can also be considered as a vector of $n$x$1$ dimensions of adolescence socioecomic indicators, where n is the number of different indicators. In that case $\gamma$ and $\delta$ are also vectors of $1$x$n$ dimension, with cells containing coefficients of different socioeconomic factors.

The main interest in the model focuses on coefficients (or vectors of coefficients) $\beta$, $\gamma_0$ and $\gamma_1$. The coeffecient $\beta$ describes the effect of the comprehensive school reform on health outcome variable on the whole sample level. The coefficients $\gamma_0$ and $\gamma_1$ describe the effect of socioeconomic factor(s) association to health outcome variable: For those individuals who were *not* exposed to the comprehensive school reform, this association is $\gamma_0$ and for those who *were* exposed the association is $\gamma_0 + \gamma_1$ Thus, they describe the adolescent age socioeconomic status gradient in health outcome variable before and after the reform. The exact interpretation is dependent on the estimation method

used and the nature of outcome variable and the socioeconomic background variable and is described in the following paragraph.

Vector *X*, the controlled variables, cointains the region of residence and the birth cohort of the individual. The last two are added as sets of dummy variables using Helsinki, the capital city and last region to adopt the reform as a reference region, and birth cohort born on 1960 as a reference birth cohort. To allow more flexibility for regional and cohort variation, interaction terms with gender were included.

The adolescent age socioeconomic status of the individual was indicated by two different variables: The affluence of the family was measured by log-transformed parental taxable income in year 1975 (with +1 added to remove the problem of 0 incomes). Parental taxable income includes earnings from labour as well as from capital income, and a number of different social security benefits for all the household members. Due to privacy reasons, the richest 3% are coded to have the same income. To take into account different sizes of households, the taxable income was divided with the number of consumption units in the households. The consumption units is calculated by adding together the number of people in household by giving the weight of 1 to the first adult (18 years or older), 0.7 to other adults, and 0-5 to every one under 18 years old. The other socioeconomic status indicator is father's highest atteined education level. The level of eduation was determined by the education level classification used by Statistics Finland, from year 2007. This includes one dummy variable for tertiary education (education classes 5-8) and one for secondary education (education level class 3), keeping the only basic level education as a reference level. In addition to socioeconomic indicators, gender is included in the vector B. The reason for this is to find out if the reform had different impact on males and females. The descriptive statistics of the socioeconomic indicator variables are in table 2. Female, and the variables describing educational achiements are dummy variables.

| | Not exposed | | | Exposed | | | All | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | mean | SD | n | mean | SD | n | mean | SD |
| female | 30582 | 0.496 | 0.500 | 26650 | 0.495 | 0.500 | 57232 | 0.496 | 0.500 |
| father's tertiary education | 30582 | 0.049 | 0.216 | 26650 | 0.081 | 0.273 | 57232 | 0.064 | 0.245 |
| father's secondary education | 30582 | 0.040 | 0.196 | 26650 | 0.091 | 0.287 | 57232 | 0.064 | 0.244 |
| parental income 1975 | 30383 | 2637.34 | 1482.42 | 26531 | 2322.57 | 1398.25 | 56914 | 2490.61 | 1452.30 |
| average adulthood household income | 30582 | 20532.44 | 8390.99 | 26650 | 19369.71 | 7500.49 | 57232 | 19991.02 | 8009.65 |
| tertiary education | 30582 | 0.386 | 0.487 | 26650 | 0.404 | 0.491 | 57232 | 0.394 | 0.489 |
| secondary education | 30582 | 0.466 | 0.499 | 26650 | 0.476 | 0.499 | 57232 | 0.470 | 0.499 |
| only basic education | 30582 | 0.148 | 0.356 | 26650 | 0.120 | 0.325 | 57232 | 0.135 | 0.342 |

Note: Household income is calculated from household taxable income, and divided by the consumption units in the household. The non-transformed unit of the income variable is 100 euros in 1975 currency

Note: Average adulthood household income is reported as annual taxable income (100€) in 2007 currency

**Table 2: Descriptive statistics of the variables in the model and the variables used for subgroup analysis, by exposure to the comprehensive school reform.**

Subgroup analysis were carried out by adulthood socioeconomic status, indicated by highest attained education level, categorized in only basic level education, secondary education (eduation level class 3) and tertiary education (education level classes 5-8), and average household taxable income within the follow-up period divided with household consumption units in the same way as parental income level. To make income levels of different years comparable, all the incomes were discounted into 2007 level by using consumer price index (Statistics Finland 2013). To calculate the average taxable income level each year when the individual was present in the dataset between 1987 and 2007 was used. By this income measure the individuals were divided into richer and poorer halves. Income halves were used instead of income quintiles to retain big enough sample size in the subgroups.

## Outcome variables and the estimation methods

### Mortality with Cox regression

Mortality was measured as survival time from birth till death. Also in this case right-hand cencoring was done in the case of dropping-out from the follow-up or at the end of the follow-up time in the end of year 2007. It's worth pointing out that due to sampling method used, the sample only contained individuals who were alive in 1987. Since the dataset also contained oversampled deaths (80% of all the deaths between 1987 and 2007), additional analysis was done with all the individuals in the dataset born between 1960 and 1966 with required information for the model (parental income, father's education, gender and region). To correct the bias from oversampling of died individuals, the sampling weights provided by Statistics Finland were used.

In the Cox regressions, stratifying was done by gender and region. This means that males and females were allowed to have different baseline hazard functions in each region without the Cox regression model assumption of constant proportional hazard over time. The analysis were also run allowing separate baseline hazard functions for different gender and having regions controlled as a full set regional dummy variables, but this didn't have significant impact on the results compared to model stratifying for both gender and region. The following results are reported by stratifying both by gender and region. Standard errors were clustered by region, to take into account possibility for intraregional correlation of residuals.

The Cox regression results are reported as hazard ratios (HR). This means that a hazard ratio over 1 means increase in hazard when corresponding variable increases, and a coefficient below 1 a reduction in hazard when the variable increases. Since the coefficients in Cox regression represent hazard ratios, the effects of different coefficients are multiplicative, not additive. For example, when

combining the effect of an interaction term to the effect of non—interaction term, the hazard ratios need to be multiplied, and not added.

### Number of hospital admissions and hospitalization days with negative binomial regression

Hospital utilization was measured in two different ways: by counting the number of admissions since age of 27 years and by counting the days spent in the hospital within these admissions.

The number of hospital admissions is simply the number, how many times the individual has been admitted to hospital after turning 27 years of age. In the case of admissions excluding deliviries, any other causes of admission are counted equally. In cause-specific admissions, only the admission with corresponding diagnosis code are counted. If the individual had several admissions on the same date, only the longest stay in the hospital was taken. This criterium was used to remove immediate (within the same day) referrals between different hospitals or different wards within one hospital. This measure, however, doesn't take into consideration the possibility that the individual is referred from ward or hospital to another later during the stay. In such a situation, admissions to different wards or hospitals were counted as separate admissions. To adjust for the different lengths in the follow up periods these numbers were then standardized into number of admissions and number of hospitalization days per 10 years.

The number of days spent in the hospital was measured as total sum of days between discharge and admission dates of each admission and adding 1. Adding 1 was done to differentiate those individuals with admissions in which the admission started and ended within the same day from those individuals who were never admitted to a hospital. This also means that number of hospitalization days can only have values which are greater or equal to number of admissions.

Number of hospital admissions and hospitalisation days are estimated with the same model, but the nature of the outcome variable requires different estimation method to be used. Table 4 shows the summary statistics of number of admissions and number hospital days. Since both of these outcome variables in these cases are count data and the variance is larger than the mean, suggesting over-dispersion of variance compared to Poisson distribution, negative binomial regression is used to accommodate this problem. The results of these regressions are interpreted in the same way as Cox regressions when the results are presented as incidence rate ratios (IRR): Incidence rate ratio over 1 means increase in the indidence of the outcome variable by as many times as the ratio shows, when corresponding variable increases by one, and below 1 means, correspondingly a reduction in incidence rate when the variable. Also the effects of different incidence rate ratios are multiplicative, not

additive. So the interpretion is quite similar: The sign and magnitude behave in the same way but the difference is that the number represents ratio in incidence rates, not in hazard.

Since hospital utilization measured with admissions by any cause also contains admissions for delivery, which should not be considered as morbidity, and changes if the fertility rate changes. To make hospital admission to reflect more overall morbidity, admissions related to giving birth were excluded from the analysis. Additionally, separate analysis was carried out with four specific groups of diagnosis. In the case of cause-specific admissions, only the admissions with diagnosis codes in question were considered as events, and all the other admissions did not matter. These groups of diagnosis were mental health –related admissions, alcohol-related admissions, accident-related admissions and cancer-related admissions. These groups were chosen, since they were among the most common causes for admission, and they have been noticed to be most important causes behind widening gaps in socioeconomic differences in life expectancy (Tarkiainen et al. 2012). The specific diagnoses codes used are in the table 3.

| | ICD-9 | ICD-10 |
|---|---|---|
| All admissions excluding deliveries | all codes excluding 650-679 | all codes excluding O60 - O99 |
| Alcohol-related admissions | 980 and E860 | F10 |
| Accident admissions | 800-999 | S- and T-category codes |
| Cancer admissions | 140-209 and 230-239 | C-category, D00-D09 and D37-D39 |
| Mental health -related admissions | 290-319 | F-category codes |

**Table 3: ICD-9 and ICD-10 codes used in categorization of hospital admissions.**

The results are reported with 90%, 95% and 99% confidence levels, and the result is considered statistically significant if it reaches 95% confidence level. The data was processed and analysed by using Stata/IC 11.2 –statistical software.

## Results

The dataset consists of 57232 individuals, 28868 males and 28364 females, from 7 different age cohorts. Out of them, 26650 were exposed to the reform went to comprehensive school, and the remaining 30582 were the controls and went to primary and civic/general secondaty school. The numbers of boys and girls in different birth cohorts and by regions can be seen the table 1. The table also shows, when different birth cohorts in different regions were exposed to the comprehensive school reform. Table 2 shows the summary statistics for the variables excluding birth cohort and regional dummy variables used in the model.

The numbers of hospital admissions and hospitalization days are shown in the graph 8 in the appendix. The steep increase first 6 years both in number admissions and hospitalization days is explained by the increasing number of individuals in the sample reaching the age of 27 years. Towards the end of the period the number of admissions increase steadily, but the number of hospitalization days decreases, making the average length-of-stay shorter. The increase in number of admissions is most likely due to ageing of the sample population, but also changing availability of services and changes in care practices can have an impact. The most probable reason for the decrease in average length-of-stay and hospitalization days is changing care practices. To differentiate the reasons behind these trends was not the primary focus, so no analysis to do this was done.

Another notable difference between number of admissions and hospitalization days is their distribution between somatic and psychiatric visits. The main diagnosis for the admission was somatical in 135451 visits admissions (excluding deliveries) and psychiatrical in 20926 visits. On average the length-of-stay for somatical visits were 3.06 days (SD 19.97) and for psychiatrical 23.19 days (SD 106.24). Thus, although psychiatric admissions only represent 13.4% of the visit, the share of hospitalization days is 53.9%.

### Effects of reform on all-cause mortality

Table 5 in the appendix shows the Cox regression results on all-cause mortality. During the follow-up, 1438 (2,51%) individuals died, out of which 1067 (3,70%) were males and 371 (1,31%) females. Average age at death for males was 39,4 years (SD 5,71 years) and for females 40,7 years (SD 5,09 years). The mortality rates of all the subgroup (in percentages of the individuals in the subgroup) analysis are seen in the table 4.

The regressions were run using adolescent socioeconomic status indicators first separately and then having both indicators jointly in the model. The effects remain the same, when both indicators are

added in the model together, which suggests that parental income level and father's education level have independent association with mortality.

For analyzing the impact of the reform and socioeconomic differences in mortality, 1398 deaths and 55516 survivors were taken in the regression. The remaining 40 deaths and 278 survivors were dropped out due to missing information about parental income or father's education. Within the whole population, the reform seemed to reduce the hazard of dying (HR 0.9211), but the effect is not statistically significant (p=0.603). The interaction term for the reform and female dummies is, however, significant (HR 0.7442, p=0.007), suggesting that the reform was 26% more beneficial for females than for males in reducing the hazard of dying. Parental income is negatively associated with hazard of dying (HR 0.8982, p=0.000) in full sample, but there was no significant association with father's education and mortality. The reform didn't significantly change the association of the parental income or father's education and mortality.

When analysing males and females separately shows that the point estimate for females is smaller then for males (HR 0.7635, p=0.515 for females and HR 0.8895, p=0.506 for males), but neither one is statistically significant. The reason for the difference in results compared to female * reform – interaction in the full sample seem to arise from difference in the effect of father's education: For males father's tertiary education is negatively associated with hazard of dying (HR 0.6804, p=0.001), while for females there is no significant effect (HR 1.3752, p=0.362). The association between parental income and mortality is very similar among males and females. The reform didn't significantly change the association of father's education or parental income level with mortality.

When running the analysis with subgroups by adulthood socioeconomic status, the risk of death decreases when the individuals own educational level increases. Within the follow-up time, those who acquired only basic level education, 5.67% died. The death rates were 2.60% and 1.16% for those with secondary and tertiary education, respectively. The hazard ratios for the reform were increasing towards higher educational groups, which would mean that the reform would have reduced the mortality gaps between them. The effect of the reform between different educational groups was tested pair-wise with two-sample t-test. The impact of reform was not significantly different between any of the educational groups, so the reform can't be said to have reduced differences between different educational groups. However, in all these three groups, the negative impact of parental income on mortality remains very strong (HR 0.9719, p=0.622, HR 0.9003, p=0.000 and HR 0.8876, p=0.000, from the lowest education group to the highest). This effect is not, however, statistically significant among individuals with only mandatory education. The reform decreased this gradient in

each of the educational groups (point estimates for HR for the interaction term was over 1), but none of the coefficients are statistically significant, which was also the case with full sample population and for both genders.

Overall, father's tertiary education seemed to decrease the risk of dying (HR 0.8040, p=0.071) but the effect was not significant with 95% confidence level. The reform didn't change the impact of father's education on mortality. When analyzing males and females separately, we see some differences: Farher's tertiary education reduced the hazard among males (HR 0.6804, p=0.001), but among females father's education did not have significant impact. In neither group did the reform change the effect of father's education. When dividing the study population by adulthood socioeconomic status, father's education is only significant in two subgroups. Those who were exposed to the reform and gained secondary education father's tertiary education increased the hazard of dying (HR 1.4811, p=0.000), and among richer half in adulthood income level father's secondary education had significant effect (HR 1.9819, p=0.000 for those not exposed, and HR 0.3561, p=0.000 for those exposed). The hazard ratios in these subgroup analysis are rather high, which can be due to relative few cases died individuals, as well as relatively few fathers with secondary and tertiary education, making the impact of random variation more significant.

As a robustness check, the analyses were also carried out with all the deaths in the dataset for the birth cohorts from 1960 to 1966. The results are very similar when the regressions are run with oversampled deaths, but there also are some differenes. The overall effect of the reform is slightly weaker (HR 0.9293, p=0.538), but also not significant. The effect of the reform was not significant for either gender, nor for any of the adulthood socioeconomic groups. Also similar results were with the effect of parental income although the point estimates were slightly closer to 1 both in the full sample all of the subgroup analysis. The main differences were found in the impact of father's education: Different adulthood education groups were effected differently by father's tertiary education, with monotonically decreasing hazard ratio, thus having a high social status family background is associated with higher mortality the stronger the lower the level education the individual will have. This can be interpreted so that falling socioeconomic status from adolescence to adulthood is associated with higher mortality.

Also similar results were gotten for the point estimates when limiting the analysis for deaths after 27 and deaths between 27 and 41 years (the age range where all the deaths for the whole sample population are in the dataset). These results are, however, not statistical significant since the number deaths is significantly smaller.

It is worthwile to notice that the sampling weights are not exactly correct, since they were calculated from 80% of all the deaths between 1987-2007, and thus they most likely overweigh the impact of the dead individuals in the study cohorts, which consists of relatively young individuals. This can be seen in the share of died individuals: In the random sample, overall death rate was 2.46% when in the oversampled population the death rate was 2.51%. Overweighting is more concentrated in lower socioeconomic groups.

### Effects of reform on hospital admissions and hospitalization days

For this analysis, the individuals who were in the dataset after the age 27 were included. Removing the individuals who had died or dropped out before this age left 56624 individuals for all admissions excluding deliveries, 56617 individuals for accidents and 56615 individuals for other disease groups. The difference between the groups comes from the selection criteria that those who were in the hospital when they turned 27, but were dropped out from follow-up right after leaving the hospital, were included in the analysis. The results for all admission excluding deliviries measured with number of admissions and hospitalization days are in the table 5 in the appendix. On average, there were 1.50 hospital admissions in 10 years per individual, and the corresponding average number of hospitalization days was 10.67 days per individual. Females were admitted more often, 1.65 times per 10 years compared to 1.35 for males, but the number of days was lower, 9.93 days compared to 11.40 days for males. Dividing the population by adulthood socioeconomic status shows that lower socioeconomic status is associated with higher number of hospital admissions as well as hospitalization days. Those who eventually have only basic level education were admitted on average 2.24 times/10 years to hospital in the follow-up period, when those having secondary or tertiary education were admitted on average 1.56 and 1.17 times/10 years, respectively. The average admission numbers for poorer and richer half in adulthood earnings are 1.88 and 1.12. According to pair-wise two-sample t-tests the differences between different socioeconomic groups are statistically significant ($p=0.000$ in each pair-wise comparison).

Similarly as with mortality, the regressions were run using adolescent socioeconomic status indicators first separately and then having both indicators jointly in the model. The effects remain the same, when both indicators are added in the model together, which suggests that parental income level and father's education level have independent association also with hospital utilization.

The effects of the reform are similar for the number of hospital admissions as they were with mortality: The incidence rate ratios were not significant in the full sample analysis nor in any of the subgroup analysis. Females were significantly more often admitted to hospital (IRR 1.3818, p=0.000). Only in the group with only mandatory education there was no significant difference between genders, but this is likely to arise from the smallest number of observations and thus larger standard errors. There was no significant difference between genders in the number of hospitalization days.

Similarly as with mortality, parental income is negatively associated with the number of admissions. Overall, the decrease was on average 0.05% for every 1% increase in income level (IRR 0.9505, p=0.000). The effect remains very similar in subgroup analysis except in the highest adulthood socioeconomic groups. In these groups the point estimates for incidence rate ratios are slightly closer to 1 and not statistically significant. The reform decreased the importance of parental income level (interaction term IRR 1.0201, p=0.018), and this effect was stongest in the lowest adulthood socioeconomic groups (for the lowest education group IRR 1.0602, p=0.023 and poorer income half IRR=1.0247, p=0.003), and not significant in other subgroups. There were no differences in the impact of parental income level between genders. When using hospitalization days as outcome variable, the association with parental income level is similarly negative, but the incidence rate ratios are smaller referring to stronger negative association (For full sample IRR 0.9179, p=0.000). The association is, however, not significant in any of the subgroups divided by socioeconomic status.

The impact of father's education on hospital admissions is less straightforward than the impact of parental income. Father's tertiary education was negatively associated with number of hospital admissions in the study population, and among males and poorer adulthood income half. The reform didn't significantly change this association in any of these groups. Father's secondary education was not significant among those who were not exposed to the reform. Among those who were exposed to the reform, father's tertiary education reduced the number of admissions among females (IRR 0.8263, p=0.005), and father's secondary education among the whole study population and females. Compared to other subgroups, the impact of father's education is different among those with only mandatoty education: In this group father's secondary or tertiary education increased hospital admissions was those with only mandatory education, suggesting that falling down in socioeconomic ladder from adolescence towards adulthood increases hospital utilization. In this group the reform also decreased the importance of father's education, although interaction term reform * father_tert_edu did not reach statistical significance (IRR 0.6620, p=0.206).

Using cause-specific admission as the outcome variable reveals some differences between different groups of diseases. In all four groups of diseases lower socioeconomic status was associated with higher number of hospital admissions and hospitalization days. The biggest gaps between highest and lowest socioeconomic groups were in alcohol-related diseases and mental health –related diseases. These socioeconomic differences in admissions and hospitalization days can be seen in Table 6 in the appendix. In none of the diseases did the reform have a significant effect on number of admissions or hospitalization days in the full sample, nor in any of the subgroup analysis, so it didn't change the socioeconomic differences in hospital utilization significantly. Compared to males, the number of alcohol-related admission was reduced among females significantly more (IRR 0.4035, p=0.017). In other cases, there was no significant difference between genders.

Similarly as with all admission excluding deliveries, parental income had similar negative association in mental health –related admissions, alcohol-related admissions and accidents, only with cancer admission the association was not statistically significant, which probably is due to low number of cancer cases in the study population. Even though father's education was significant in many instances, there was no clear pattern in the effect, which is most likely due to the fact that there are too few incidences in the the categories of father's secondary and tertiary education, making them sensitive for random chance.

The results with cause-specific admissions and hospital days should be considered with caution, since the number of cases and and individuals affected is relatively small. This is likely to be the reason for rather high and low incidence rate ratio point estimates. This was particularily evident with cancer admissions, in which the highest incidence rate ratios were over 33, and lowest 0.015, which are clearly result of too few observations.

## Conclusions

The picture that can be formed about mortality in this study is not complete, since the dataset only contained information about individuals who were alive in the beginning of 1987, leaving out the individuals who might have been in the study sample, but died before that. The picture that can be drawn, however, is similar to picture seen in other studies: Lower socioeconomic status, whether measured by adulthood income level or educational atteinment, is always significantly associated with higher mortality and more hospital utilization, which gives some assurance that the results are reliable.

Basic level education seems to have slightly bigger impact on females than on males. When it comes to mortality, females seemed to benefitted the reform in the full study population, and even more so in the lowest and highest educational groups, and in the richer adulthood income half. When allowing different effects for parental income and father's education, the difference between genders was smaller and not significant, but the point estimates are still more beneficial for females. It is, however, important to notice that early deaths are far more common, in this study almost 3 times more common, among males than among females. Thus, the results among females are more sensible for random chance, and there is more power to uncover more subtle associations in male deaths. Also, the robustness check didn't confirm this finding, so at this stage the result should be considered with caution.

The effect of the reform was not significant in any of the socioeconomic groups. The monotonically increasing trend in the hazard ratios in mortality and incidence rate ratios in hospital utilization from lowest to highest educational group, however, are suggesting that lower educational groups might have benefitted more, but the statistical significance is rather far from being significant (p-values vary between 0.373 and 0.750 in Cox regression and between 0.181 and 0.736 in negative binomial regression for admissions). When using income halfs as socioecomic indicator, the point estimates for hazard ratio are more beneficial for richer half.

Regardless of the adulthood socioeconomic status, higher parental income always seems to be associated with a lower hazard of dying, and in most of the cases also with higher rate in hospital utilization. Only in the lowest educational group this association was not significant, probably due to being the smallest subgroup, but the point estimate was similar to other groups. Although in every subgroup analysis the effect of the reform was making this gradient smaller, these results were never significant. This stresses the complex mechanism how socioeconomic factors on health: Even though the socioeconomic status improves later on in life, early life socioeconomic status still bares importance. This study design doesn't, however, reveal more of the exact mechanisms how this is transmitted. The comprehensive school reform seemed to reduce the importance of parental income, and this effect was especially lowest socioeconomic groups, both when using or individual income level as socioeconomic indicator. What exact mechanism how the reform made this happen can't be, however, determined with the model used in the study. This would need differentiating the effects of changes in curriculum and school tracking age, which might prove difficult, since the changes were made simultaneously.

## Discussion

The main conclusions of this study are that the comprehensive school reform may have had a pro-female effect on mortality between sexes, which suggests that the reform should have increased the life expectancy gap between genders. Soon after the reform, however, there is clear pro-male change in trend in difference in the life expectancy gap. Secondly, the reform didn't have a significant effect of socioeconomic distribution of health measured by mortality and hospital utilization. Third, parental income is associated adulthood mortality and hospital utilization regardless the socioeconomic status in adulthood. And finally fourth, the comprehensive school reform reduced the association of parental income on number of hospital admissions especially among lower socioeconomic groups, and reduced the importance of father's education on hospital admissions within lowest educational group.

### Effects on mortality

The finding that the reform might be increasing gender differences in life expectancy is not definitive. There are two types of life expectancy measurements, period and cohort life expectancy. The first one, period life expectancy is typically used as a public health measure, since it can be calculated each year with the mortality numbers of that year, including all the deaths. The numbers published for example by Tarkiainen et al (2011) shows the trends in period life expectancies in different income groups. The other one, cohort life expectancy, requires follow-up of a cohort until everyone in the cohort has died, or estimations of future mortality rates that the cohort will experience. The dataset contained only deaths in the sample population in 21 consecutive years between years 1987 and 2007, so it provides only limited observation window to cohort life expectancy. This information, of course, doesn't allow calculating actual life expectancies, not even giving accurate estimates on the change in life expectancies due to the reform, since no information is available about mortality in other age groups. But since the reform had small beneficial effect pro-females, it seems that the comprehensice school reform doesn't help to explain the narrowing gender gap in life expectancy between years 1987 and 2007. Due to the sampling method used to collect the dataset, no deaths prior to 1987 were included. To include earlier deaths in the analysis would be interesting, since the declining trend in gender difference in period life expectancy has been already been observed after year 1978. It is, however, very unlikely that the comprehensive school reform by itself would have had a strong impact on life expectancy so quickly.

Earlier studies have found that the comprehensive school reform in Finland has been more beneficial for females by increasing the differences for educational atteinment, which was already more favourable for females when considering how likely an individual is to choose academic education track, and decreased wage gap between sexes, which was favourable for females (Pekkarinen 2008).

Since both educational attainment and income have both negative correlations with mortality, it is logical that the reform would also have more beneficial effect on mortality for females than for males.

Similar results about more beneficial effects for mortality specifically among females in mandatory schooling reforms have been reported in some countries: Most notably in the Netherlands in 1928 (up to 40 years after the reform), and in Northern Ireland in 1972 (up to 20 years after reform). Actually, more often the educational reforms have benefitted males more: In Belgium (up to 50 years after reform) and in the Netherlands (up to 40 years after the reform), and for shorter time span also in Austria, France, and the United Kingdom (within separate reforms in Northern Ireland, England/Wales and Scotland). However, the focus of these reforms has more been on the extension of mandatory schooling years than on quality issues of basic level education (Gathmann, Jürges & Reinhold 2012).

In Sweden, where the reform included both extension of the mandatory schooling and postponing the school tracking age, overall the reform had a small beneficial effect on mortality, but there was no significant difference between sexes. The comprehensive school reform was adopted in Sweden 23 years earlier, so their follow-up period allows examining also deaths in the older age, enabling far broader picture to be drawn. They have also analysed the deaths before the age of 40 separately, and found that the reform didn't have a significant impact for the mortality. The point estimate slightly smaller for females (1.02 vs. 1.03 for males), but due to clearly smaller amount of deaths (8526 vs. 18496 for males), the 95% confidence interval is larger and encompasses the whole confidence interval for males. Also for deaths after 40 years of age, the point estimate is more beneficial for females (0.95 vs. 0.96 for males), but again, the difference is not significant (Lager, Torssander 2012).

### The association with parental income

The importance of parental income seemed to be consistent finding in this study, both with mortality as well as overall morbidity. Very similar findings have also been made in Sweden (Palme, Sandgren 2008). By using Kaplan-Meier non-parametric as well as Cox regression models that parental income was negatively associated with mortality, also when controlling for individual life-time earnings and educational attainment later in life. Also Jones, Rice and Rosa Dias found associations between father's socioeconomic status and ill health, but they have used father's occupational status as indicator of socioeconomic status (Jones et al. 2010). As the Finnish report about trends in socioeconomic health differences (Palosuo et al. 2007) points out, the knowledge about socioeconomic differences in health behaviour among young people is rather limited, and mostly based on cross-sectional surveys. Understanding the mechanism how adolescent age socioeconomic

factors influence on health later in life may help to design policies and interventions to tackle these problems. The finding also suggests that interventions at young age have also a role in reducing the socioeconomic inequalities in health later on in life.

### Considerations about material and methods

The strength of using hospital discharge records is that it can be considered as fairly reliable source of information. Especially in Finland, where the hospitals are mostly municipality owned and submit their information to a common national registry, the information is also covers vast majority of all hospital admissions. Using this type of information as a proxy for morbidity has, however, three kinds of problems. First problem is that not all types of diseases require treatment in the hospital. This group of diseases includes for example many chronic conditions and infections, which have major importance in public health sense. The second problem may arise from the accessibility of hospital services for different groups of people. If socioeconomic status has an effect on availabity of services, it may cause a bias, which then is seen as morbidity difference between different socioeconomic groups. The third problem is a related to the certainty of the diagnosis associated to hospital discharges. Since some diagnosis is required for every discharge, some diagnosis needs to be given also when the diagnosis in not clear. Typically the diagnosis which describe the symptom but not the disease are diacouraged in hospital settings. For a study like this one, the first two problems can cause difficulties while the third one is likely to have less importance. First problem could be solved by gathering information from different sources, such like out-patient visits and pharmaceutical purchases. At the moment of this study, however, in Finland no national registry about out-patient visit in health centres were available. Information about pharmaceutical purchases were available, but due to time constraints, this part of dataset was not included in the study. To tackle the second problem would need information about the need of services, which is usually very complex issue measure and difficult to obtain. The basic mechanism would be to include variables in the model as control variables that would explain the need of services. What these variables should include is an open question and subject to a debate.

The difference in results when using the number of hospital admissions and hospitalization days is curious. The reason probably arises from the fact that some individuals may spend many days in the hospital treatment due to nature of the disease (especially psychotic conditions), treatment complications or other external reasons, even though they have fairly few visits. These two variables describe different aspects of morbidity: Number of admissions may reflect the number of different episodes of illness when number of hospitalization days may reflect the need of hospital services in the treatment of different diseases. The need can depend on the nature of the of the disease, severity of

the condition, and it can also reflect the care practices of the country, in which there may also be some regional variation. It is, however, worthwhile to notice that lower socioeconomic status is associated with longer stays in hospital more clearly than number of admissions: When comparing groups with only mandatory schooling and tertiary education, number of admissions have 1.91 times difference (2.24 vs. 1.17 admissions per individual in 10 years) and hospitalization days 3.98 times difference (23.86 vs. 6.00 days per individual in 10 years). One reason for this is that psychiatric illnesses and disorders, which have longer average length-of-stays, are more heavily concentrated among lower socioeconomic groups: from those with at least one admission with psychiatric diagnosis within the follow-up period 36.6% have only basic level education, compared to 19.1% among those with no admissions with psychiatric reasons. To understand the differences between these variables better, more diagnosis specific analysis would be needed, but that falls beyond the scope of this study. Simple answer to question which variable is more suitable to be used as indicator for morbidity can't be given, since their qualities are likely to vary between different diagnosis.

It would also be tempting to use the reform as an intrument for years of education and the use years of education to explain the morbidity and mortality. This would allow saying something about the causal relationship between years of education and health. The requirement for this would be that the reform should not have any other impact on morbidity and mortality than the impact through years of education. The possibility of using the comprehensive school reform as an instrument for years of education has been examined within Swedish compulsory school reform (Holmlund 2008). In Sweden the reform extended the mandatory schooling by 2 years and increased the school tracking age by approximately same amount as the Finnish reform, from 11-13 years of age to 16 years of age. Since Finnish comprehensive school reform also changed the curriculum of the basic level education and the age when children are tracked to different schools, it might be too strong assumption that the impact would only be transmitted through length of education. Another feature in the reform making the use of reform as an instument for years of education was that the decision about the reform was already made in the 1968, but the implementation started in 1972. This makes it possible that municipalities may have adjusted their civic schools to meet the requirements of the reform, for example by extending the length of civic school to 5 years, and thus no extension of basic level might have not happened at the actual year of the reform. Also, some children already had 9 years of basic level schooling if they were tracked to general secondary school after primary school. Although no detailed analysis about possibility to use the reform as an instrument was made in this study, by comparing the Swedish and Finnish comprehensive school reforms, it seems that Finnish comprehensive school reform is likely to be weaker instrument than corresponding reform in Sweden and there are good

arguments for it to be correlated with health outcomes through other pathways than years of schooling.

There are also a few earlier studies that have examined impacts of school quality instead of years of schooling on health related outcomes. Fletcher and Frisvold have examined the impact of college selectivity on health behaviors with survey based data collected in Wisconsin Longitudinal Study, which includes information about schooling, social background, labor market experiences, and health behaviors. They try to control for pre-college factors by using siblings who have attended different colleges. They found a significant negative association between college selectivity (which is considered as a proxy for college quality) and obesity around the age of 65, and no association with smoking at the same age. The overall impact was 4-6% decrease in BMI and 15-18 %-point reduction in prevalence of obesity among those who attended very competitive colleges compared to other students (Fletcher, Frisvold 2012). Another study by Jones, Rice and Rosa Dias finds that school attainment has an impact on smoking, alcohol consumption and eating habits, but the relationship between ill health and attainment is only found with individuals who attended (or would have attended) at early stage academically more intense grammar school instead of secondary modern schools, which suggests that quality of early schooling maybe a catalyst between school attainment and health otucomes (Jones et al. 2010).

Although this study focuses on the comprehensive school reform, it is also worthwhile to notice that many other features that are usually considered important for the quality of the school system and to public health have been established already during the primary/civic/general secondary school era years before the comprehensive school reform. These include for example high requirements for teacher's educational background and free school meals for all the pupils, which are not all that common in international comparisons. They also might have effects for socioeconomic differences in health, but those effects can't be examined in this study.

### Suggestions for further research

To get a broader picture about the effects of the comprehensive school reform and the importance of basic level education on health, further research is needed with longer follow-up time and other indicators as outcome, including more information on chronic conditions with major public health importance, such as diabetes, cardiovascular diseases and depression. To verify the finding about different impact of the reform on mortality for males and females, a bigger sample and deaths in other age groups would be needed. A bigger sample would also enable to investigate cause-specific

mortality and more accurate analysis of the effects for different socioeconomic groups, both of which now are not conclusive due to weak power within the subgroup analysis.

The comprensive school reform can also act as an example, how different policies could be implemented to enable studying the effects of different policies. Quasi-experiment settings are a useful way to examine causal relationships when randomized controlled trials are not possible, which is typically the case with health and educational policies. This is not merely serving academic interest but also as a tool for reaching closer to worthy goal of evidence-based policymaking.

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