

Economic Stress in the Short and Long Term and the Onset of Ischemic Heart Disease

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Abstract

Cardiovascular diseases are today the main causes of death in developed countries, accounting for more than 40 percent of all deaths. The main motivation for the study is the link repeatedly found in empirical research between income and Ischemic Heart Disease (IHD), typically explained as the result of a stress related effect originating from a poorer labor market performance. Previous studies have already emphasized the importance of a lagged measurement of income. Otherwise, due to sickness absence and recuperation following an IHD event income, measured during the same year as the IHD event, would have high probability of being affected by the event itself.

This study exploits a longitudinal dataset consisting of about 50,000 Swedish men and women during the years 1992-2001, and examines the short and long effect of income on the risk of experiencing their first IHD event using logistic random effect regression. The focus on the onset of IHD is cancelling out the effect from the degenerative nature of the disease, which is increasing the risk for another IHD event massively after an initial event. More specifically, the study examines whether the individual's absolute or relative income deprivation is more important. In the paper, relative deprivation is measured as the share of the individual's earnings compared to what they should earn, given their gender, age and educational level and type.

The study is taking advantage of a large dataset and a very precise as well as long-term measurement of absolute and relative income. The study finds no strong indications that a significant difference exist between the risk of experiencing the first IHD event between the highest and lowest category of earners.

Introduction

Empirical research on numerous contemporary western societies displays a coherent body of evidence of a negative association between an individual's economic attainment and the incidence of Ischemic Heart Disease (IHD) (Cabrera, 2001; Henriksson, 2003; Toivanen, 2007). The interest in the determinants of various cardiovascular diseases is of particular relevance in the developed regions of the world, where IHD stands out as the main specific cause of death (WHO, 2008). As a consequence, the relevance of obtaining a better understanding of the underlying causes of IHD is difficult to overestimate. This paper focuses on the case of Sweden, where over 40 percent of all-cause mortality is due to cardiovascular disease, of which 22 percent are attributable to IHD (Socialstyrelsen, 2009). This article exploits a longitudinal sample of 50,000 unique individuals between 1987 and 2001, investigating the short and long-term influence from income attainment on the risk of experiencing the first IHD event.

Despite cardiovascular disease being the main cause of death in Sweden, its prevalence has diminished considerably during the last two decades. The main causes for the decline in IHD are believed to lie in reductions in smoking as well as lower levels of blood fat (Socialstyrelsen, 2009). At the same time, an increasing share of the Swedish population is overweight or obese, which is strongly correlated with diabetes and hypertension. This is partially counteracting the generally declining trend in the incidence of cardiovascular disease. Parallel to the decline in the incidence of IHD as well as other cardiovascular diseases, considerable advances in the treatment have led to substantially improved survival rates among those afflicted.

The importance of obtaining a better understanding of the causes of IHD as well as other cardiovascular diseases is, however, not only of concern to the individual, who – in avoiding experiencing IHD – may avoid dying prematurely. Taking into account the high prevalence of cardiovascular disease and the massive medical interventions that occasionally are necessary, the subsequent societal costs are substantial. Figures from the UK (Luengo-Fernández et al., 2006) demonstrate high costs for the health system due to cardiovascular disease. Similarly high expenditures for treatment of cardiovascular disease can be found in the US (Wang et al., 2004) and the Australia (NPHP, 2003).

Swedish has a universal health care system that is almost entirely financed by taxes. Nevertheless, health care costs associated with cardiovascular disease represent a substantial share of total health care costs in Sweden. This is the result of a large number of patients, but also from being medical conditions frequently requiring extensive hospital care. Figures from 1995 suggest that the yearly cost for patient being treated for any cardiovascular disease amounts to roughly 19 billion SEK (in 2010 figures), including both direct costs (e.g. hospital care, pharmaceuticals) and indirect costs (e.g. sickness benefits) (Socialstyrelsen, 2001).

The key determinants of IHD are typically related to the health behavior of the individual, such as overweight and obesity, smoking, alcohol use and dietary habits. However, a strong link between socio-economic status and the incidence of IHD remains even after controlling for aforementioned behavioral characteristics. The simplified overall conclusion is that individual in higher socio-economic positions experience better health than their counterparts in lower socio-economic positions (Lynch et al., 2000). The magnitude of this relationship depends strongly on measurements of socio-economic position and health outcomes, often measured as life expectancy (Mackenbach et al., 1997; Wilkinson, 1996).

In the Nordic countries, the existence of universal health care could be expected to reduce the effect of income on IHD. The rationale underlying this argument stem from the fact that access to treatment for risk factors such as diabetes and hypertension, among others, should not be related to the individual's economic resources. However, knowledge about health care options and access to them is correlated with socio-economic factors like social integration and education. Therefore, the existence of an income gradient similar to countries where access to hospital care to a greater extent is determined by a person's earnings is still possible.

While previous studies generally suggest that low earning individuals are at the greatest risk of suffering from IHD, few studies have addressed the empirical shortcomings of these results. Unfortunately not all studies have the possibilities to work with longitudinal data and therefore the chance of measuring income at more than only one point in time. Further, some studies don't distinguish between the onset and all IHD events over the life time of a person. This paper overcomes some of these shortcomings by exploiting a longitudinal panel, covering an extended time period. The

result remains consistent across several model specifications as well as to two different income measurements. Apart from using a traditional income measurement, the results are robust to the use of a measurement of relative income, thereby testing the relevance of the relative deprivation hypothesis.

Theory

Theoretically, the link between an individual's attained income and the risk of experiencing IHD should be understood in terms of access to and knowledge of health commodities as well as the sense of well-being resulting from a certain monetary remuneration from work. As previously mentioned, due to Sweden's universal health care system, access to health treatment should be comparatively weakly linked to the individual's income. That being said, income remains a direct measurement of the individual's access to a range of indicators of material well-being. While in earlier centuries income was indicating if the basic needs for food, shelter and safety are secured, income in contemporary developed countries is a measurement of neo-materialistic assets (Blane et al., 1997; Macintyre et al., 1998). Income is correlated with the individual's quality of housing, access to health promoting procedures as well as the individual's free-time activities and dietary preferences. Individuals in the lower end of the income distribution are hereby assumed to be more likely to be suffering from worse living conditions, provoking physical problems and distress which could trigger IHD.

A continuously stressful situation may provoke a protective mechanism in the human body to cope with the situation (Selye, 1955; Dhabhar, 2000; McEwen, 2002; McEwen et al., 2010). In order for this reaction to be harmful the stress situation does not have to be life threatening. Nowadays, in developed countries many resources of stress are resulting from modern life style and social structures (Karasek, 1979). To the extent that such stress originates from the individual's position in the labor market, those in disadvantaged positions are usually disproportionately exposed to stressors.

The explanation how stress is affecting the human body, resulting in disease and poor health has been studied in the field of medicine and epidemiology for a long time (Selye, 1955). Stress can occur from acute events or from enduring stressful situations. Short term stress enhances stress hormone production and pushes the immune system to cope with a more intensive work load. If the stressful

situation continues, this protective and adaptive mechanism turns into a health risk (Dhabhar, 2000). Long-term stress is assumed to lead to changes in the bodily functions which increase the risk for several illnesses, like cardiovascular diseases. Long-term stress and its resulting disturbance in the metabolism and hormone balance can cause elevated blood circulation or increased inflammation risk (McEwen et al., 2010).

Studies have identified two possible pathways from economic stress to disease. A direct impact is characterized by changes in metabolism, inflammatory and haemostatic system through the dysfunction of the autonomic nervous system and of the hypothalamus-pituitary-adrenal-axis, provoked by the stressor (László et al., 2010). Higher inflammatory markers were found in individuals with high economic stress, measured as low annual income (Gémes et al., 2008). Several studies have shown current income having a strong impact on health outcomes (Ecob et al., 1999; Yngwe et al., 2001). Elevated inflammation and thrombotic functions support the progress of coronary atherosclerosis, the main cause of coronary heart disease (Libby, 2002; Hansson, 2005). In the second pathway the stressors will act as a mediator for changes in health behavior, triggered by economic stress and unfavorable socio-economic conditions (Gémes et al. 2008). Especially the lack of physical activity, an unbalanced diet, accelerated smoking and sleeping dysfunction are important cardiovascular risk factors. The assumption is therefore that individuals who are exposed to continual economic stress will experience an increased risk of the incidence of cardiovascular events.

The preceding discussion has essentially focused on the theoretical link between achieved income, in absolute terms, and the extent to which individuals on average can be believed to suffer from stress. This perspective fails to take into account the widely differing income distributions across different occupations and the implications this has as regards whether a given achieved income is to be interpreted as that of a high- or low performing individual. According to the relative deprivation hypothesis, a key dimension to consider is how an individual is performing compared to their peers. More specifically, the income performance of an architect should be adjudged in comparison to other architects. Underlining the importance of an individual's relative rather than absolute position, Eibner et al. (2005) suggest that a substantial part of the decline in mortality that is associated with an increase in income is due to a *relative deprivation effect*. Evidence of the existence of a physiological

response to relative status has been provided by studies on nonhuman primates, essentially confirming similar mechanisms as the response to absolute status. Sapolsky (2005) outlines a number of responses to prolonged stress which increase the risk of cardiovascular disease, such as hypertension, elevated heart rate and increased circulating levels of lipids and cholesterol.

Methods

A static measurement of income is not an optimal approach, because an individual could be observed in a temporary situation which would over- or underestimate their long-term earnings. Furthermore, the literature typically focuses on the negative health effects of *prolonged stress* rather than short-term exposure to economic hardship (Dhabhar, 2000). Ideally, income should therefore be measured over time to investigate the impact of economic stress on health (see for example Lynch et al., 1997 or Chaix et al., 2006).

In the study, data on a sample of approximately 50,000 individuals, spanning the time period 1992-2001, was selected from the Swedish Longitudinal Immigrant database (SLI). The database consists of a representative sample of native Swedes as well as immigrants from 16 different countries of origin. Individuals are followed on a yearly basis and the sample includes both men and women between the ages 40 and 65. Since the focus of the paper primarily concerns the link between stress resulting from a poor labor market performance, individuals are censored from the time they acquire any income from pension.

In this study, the event of interest is the incidence of IHD. This information was obtained from the Swedish hospital discharge register and is recorded with daily precision. In the analysis it is used as a binary variable indicating if the individual experienced an IHD event during the given calendar year (ICD9 & ICD10 codes), between 1992 and 2001. The explicit purpose of the study is to achieve better understanding how the individual's short- and long-term economic situation influences the risk of experiencing an IHD event. While a negative income shock occurring during a given year may cause considerable psychological distress, previous research would strongly suggest stress as being more likely to result from a more long-term exposure to economic hardship (Hansson, 2005). The most straightforward way to measure one's economic situation is simply to gauge the financial resources

raised by the individual. Here, this is measured as the individual's inflation adjusted pre-tax income in 1987 Swedish crowns (SEK). This measurement indicates the amount the individual receives from many resources and therefore also contains income from unemployment and sickness benefits besides wage.

However, the absolute amount of income or wage can be misleading since the relation between income and health benefit is not straight linear (Kawachi et al., 2000). Individuals in low income groups profit more than individuals in higher income groups when their income is increased by the same absolute amount. Other studies have suggested the importance to express the individual's labor market performance in relative terms (Wilkinson, 1996; Fritzell et al., 2004; Dohmen et al., 2011). More specifically, human capital investments are made based on – at least partly – expectations about their future returns in terms of monetary remuneration. As a result, a given income is – by definition – a better performance in occupations characterized by lower average incomes. Therefore, this study will investigate income as well as a relative income measurement, taking the age, sex and educational level of the individual into account. In order to investigate the short- and long-term IHD response to the individual's absolute and relative economic status, a set of models are estimated, considering the individual's attained income for as long as the preceding 10-year period.

Minimizing the risk of reverse causality is a key priority for this study, as the individual's income in the year of the IHD event could be affected by the event itself (Hemström, 2005). Even when ignoring income attainment during the year at risk, several other factors may contribute to problems in estimating the influence from an individual's income on the risk of experiencing IHD. Firstly, left truncated data could imply that a poor income performance several years before being at risk of experiencing IHD is due to having previously experienced the event. Further reinforcing this risk is the fact that individuals who experience IHD once are highly likely to experience the event again (Kannel et al., 1991). In the data, individuals with multiple IHD events experience the next event in over 75 percent of the cases within a year after the previous. In 95 percent of the cases the reoccurring IHD events happen within five years after the previous event. Because of this potentially quite substantial problem, the empirical strategy of the paper relies on the analysis of individuals who – prior to the first year at risk – are observed during five consecutive years without experiencing the event. By doing

this, the ambition is to effectively exclude the vast majority of those whose observed income as well as risk of experiencing the event of interest is biased by a prior IHD event. Furthermore, the paper examines the time until the individual's *first* IHD event. Due to the high survival rate from IHD, combined with the recurrence of IHD events, examining the link between income and IHD risk subsequent to the first event is likely to be associated with substantial endogeneity problems.

Lastly, two additional restrictions are imposed as the interest of the paper regards individuals in working ages. In order to ensure a certain level of labor market participation, individuals need to enjoy a pre-tax income exceeding two base amounts, during the current year. The base amount represents an index of price movements, used to calculate the pensionable income, pension points and maximum levels within social insurance (Bengtsson et al., 2006). Furthermore, the individual needs to be observed in the data – with or without enjoying an income - during all preceding ten years. Following previous research that suggest substantial gender differences in IHD incidence rates (Wu et al., 1981; Brunner et al., 1993; Nikiforov et al., 1998; Vogels et al., 1999), the analysis is stratified by sex.

In the models, several medical and socio-demographic characteristics are included, such as having been treated for hypertension, diabetes and age. Since sickness absence may be an indicator of morbidity, which could both affect the individual's earnings as well as being linked to experiencing IHD, previous spells of sickness absence are taken into account. Similarly, previous spells of unemployment are included in the models. This is operationalized as a dummy variable indicating whether unemployment benefits were the greatest source of pre-tax income during a given year.

While the models control for all available determinants of IHD, the dataset does not include information on smoking habits or other health behavior. To the extent that such characteristics remain constant within a given individual over time span in which they are observed, logistic random effect regression exploits the panel structure of the data to cancel out the influence of unobserved and time constant characteristics. Should this assumption be violated, it is believed that the omitted variables are negatively related with income attainment. As a consequence, the income effect would be overestimated in the models. All models include year and age dummies, making them essentially analogous to duration models. Due to the aforementioned strong link between previous and subsequent

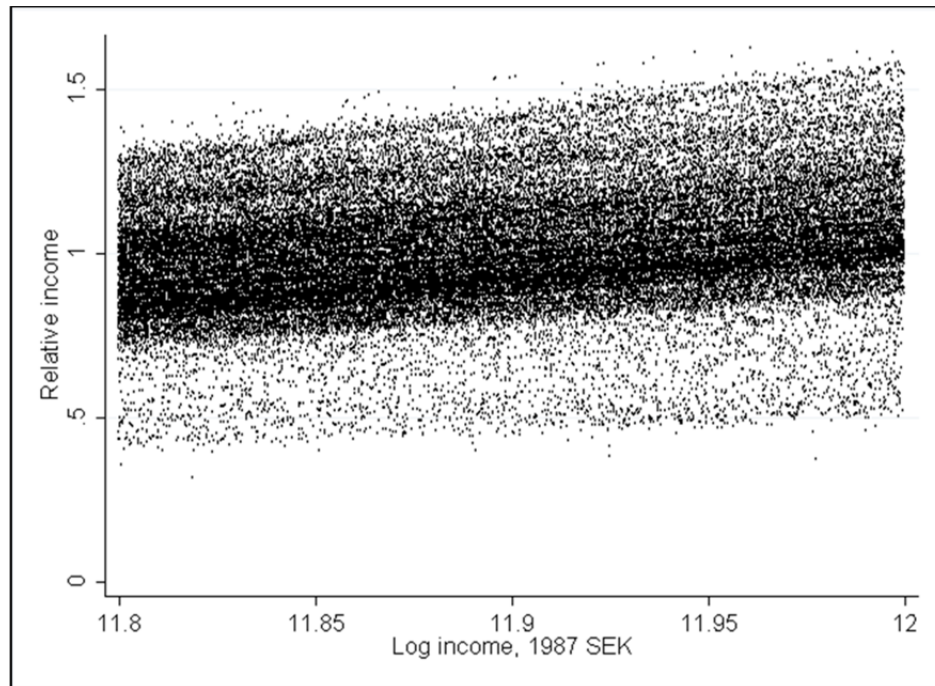
IHD events, the models estimate the risk of experiencing the first (observed) IHD event, after which individuals are right censored.

Descriptive statistics

Despite IHD being a recurrent disease among those afflicted in the age range of interest in this paper, it does not affect a large share of the population. Among the 49,159 individuals in our sample between the ages of 40 and 65, only 3.3 percent were censored due to experiencing a (first) IHD event, amounting to 1,640 events. While this figure may appear small, especially given the importance of IHD as a cause of death, it corresponds very well to macro estimates provided by the Swedish Board of Health and Welfare (Socialstyrelsen, 2011).

A main prerequisite for the relevance of this paper is that the two income measurements chosen here – pre-tax income and relative income – are not essentially measuring the same thing. While higher income in absolute terms should be associated with higher relative income as well, differences in the income distribution between individuals with different levels and types of education should imply that a given income is associated with a range of different relative incomes. Figure 1 shows the distribution of relative incomes around the sample mean pre-tax income. The positive slope demonstrates that relative incomes indeed on average increase with income in absolute terms. The figure however also suggests a considerable relative income variation at any given absolute income, with log inflation adjusted incomes around 11.9 is associated with relative incomes ranging between 40% and 150%.

Figure 1: Log income and Relative income of about 50.000 Swedish men and women between the years 1992-2001



Lacking strong *a priori* expectations regarding the functional form of the relationship between IHD and either of the income variables, the choice in this paper became to divide the income variable into categories at every 20 percentile, displayed in table A1 in the Appendix. Similar strategies, albeit with different thresholds have been applied in previous research (see for example Andersen et al. 2003, Chaix et al., 2006 or Osler et al., 2003).

Theoretically, the harmful influence from stress on the risk of experiencing IHD is viewed as being the result of a prolonged and persistent exposure to economic hardship. In this paper, stress is treated as resulting from the individual's absolute and relative position in the income distribution. Analyzing the instantaneous influence from income on IHD risk, as is predominantly the case in the literature, thus essentially hinges upon an assumption that an individual's income in time t is a valid approximation of long-term earnings. That this may not be a valid assumption is indicated by the relatively low correlation between income at time t and the average income during the preceding ten years (0.58). While this number may be influenced by age-effects which distort the correlation coefficient, the relative income measurements should be rid of such disturbances. Despite this, the similar correlation

coefficient for the relative income variable is very similar (0.56), suggesting that income at time t is far from a perfect predictor of previous years' incomes.

Results

Table 1 displays results from gender-specific regression analyses on the determinants of the first IHD event. The models focus on absolute income as an IHD determinant, taking into account the individual's performance up to ten years prior to the time at risk. Again, it deserves to be underlined that all included individuals in the sample have not experienced an IHD event in the five-year period preceding the first year of risk. As a result, the ambition of the approach is to avoid the risk that the probability to experience the event and the individual's labor market performance is affected by previously having suffered from an IHD event.

As it is frequently done in previous research, the first column examines the association between attained income and the risk of IHD, both measured during the same year. Especially for males, the dramatic difference between high and low income earners is familiar from previous research. Indeed, belonging to the lowest income quintile is associated with a risk that is 38 percentage points higher than for men in the reference category and 68 percentage points higher than the highest quintile, respectively. For women, point estimates suggest an even more evident pattern where the both lowest earners quintiles suffer from an elevated risk of IHD. The typically wider standard errors however suggest considerable variation in the response within a given income quintile, compared to males. Different to the male results, the reference group is experiencing the lowest risk, while higher income quintiles have higher risks again.

Table 1: Random effect logistic regression on first IHD event. Absolute income quintiles, in 1987

SEK

MEN													
Income quintile	time t				time t-1			5-year-lag average			10-year-lag average		
	OR	95 % confidence interval			OR	95 % confidence interval		OR	95 % confidence interval		OR	95 % confidence interval	
00-20	1,382	**	1,053	1,815	1,267	0,960	1,671	1,108	0,818	1,499	0,978	0,711	1,343
20-40	1,159		0,908	1,479	1,096	0,852	1,410	1,125	0,859	1,475	1,093	0,831	1,436
40-60	ref				ref			ref			ref		
60-80	0,909		0,716	1,154	0,935	0,736	1,188	0,912	0,710	1,172	0,918	0,713	1,182
80-100	0,704	**	0,533	0,929	0,846	0,643	1,113	0,771	0,574	1,036	0,776	0,578	1,041

WOMEN																
Income quintile	time t				time t-1			5-year-lag average			10-year-lag average					
	OR	95 % confidence interval			OR	95 % confidence interval		OR	95 % confidence interval		OR	95 % confidence interval				
00-20	3,284	***	1,997	5,399	2,066	***	1,321	3,231	2,032	***	1,2644	3,2645	1,636	*	1,021	2,622
20-40	2,108	***	1,289	3,448	1,149		0,733	1,803	1,436		0,9002	2,2912	1,129		0,706	1,806
60-80	1,049		0,552	1,996	0,544		0,288	1,027	0,563		0,285	1,1133	1,242		0,684	2,255
80-100	2,096	*	1,006	4,366	1,172		0,569	2,414	1,751		0,822	3,7281	0,909		0,378	2,183

Notes: *** 1%, ** 2.5%, * 5% statistical significance

While the aforementioned results may be affected by reverse causation, where income is affected by IHD rather than the other way around, lagging the exposure variable reduces the most obvious such issues. Examining income during the year prior to the year at risk substantially changes the results. For both men and women, the trend remains similar to that previously observed, but it has become more problematic to separate the parameter estimates, using 95% confidence intervals. For women, the range between estimated effects for the highest and lowest income quintiles has diminished considerably (OR for the lowest quintile 2.1, OR 1.2 for the highest quintile) and only the lowest income quintile is significantly different from the reference category. For men, all parameter estimates are statistically insignificant and characterized by overlapping confidence intervals. By removing the most evident source of reverse causality, the income effect reduces considerably for women and disappears for men completely.

Very little changes when extending the time period in which the individual's earnings are observed. It needs to be underlined that the sample size is not affected by the lag structure of the models, so the

results are unaffected by such changes. For men, all estimated effects for the different income quintiles almost consistently approach an odds ratio of one as the income lag increases. Examining the influence of the individual's average earnings during the preceding 10-year-period, point estimates suggest an odds ratio for the lowest earners of 0.98 and 0.78 for the highest earners. Consistently, the estimates are statistically insignificant and with overlapping confidence intervals. For women, the lowest income quintile remains different from the reference category, examining both 5 and 10-year-lagged averages. The confidence intervals of the other quintiles however, overlap and are therefore indistinguishable from each other. The results would clearly suggest weak or no evidence of a link between earnings and the risk of experiencing the first IHD event, either in the short or long run. Acknowledging Sweden's universal health care system and that medication is heavily subsidized, the results appear to lend support to the hypothesis that access to preventive health care is independent of an individual's earnings.

As outlined in the theoretical section, another source of stress may arise from continuously experiencing a poor match to the labor market. Such a situation may represent itself by the failure to obtain earnings comparable to individuals sharing otherwise similar characteristics. In order to test the relative deprivation hypothesis, the models displayed in Table 2 examine the link between relative income and risk of first IHD. While difficult to directly compare parameter estimates between absolute income models and relative income models, the link between relative income quintiles and the IHD risk measured during the same year displays a largely familiar pattern. For men, individuals with relative incomes above the 60th percentile enjoy a significantly lower risk of IHD than those with relative incomes below the 20th percentile, ranging between a 55 and 62 percentage points lower risk. For women, point estimates suggest an even steeper income gradient, but the size of the confidence intervals makes the task of separating the effects impossible. The statistically significant effects for the two highest income quintiles (q4: OR 0.61, q5: OR 0.56) does however suggest that high relative income earnings among women is correlated with a de facto lower IHD risk compared to the reference category, represented by women with relative incomes between percentiles 40-60.

Table 2: Random effect logistic regression on first IHD event. Relative income quintiles.

MEN												
Relative income quintile	time t			time t-1			5-year-lag average			10-year-lag average		
	OR	95 % confidence interval		OR	95 % confidence interval		OR	95 % confidence interval		OR	95 % confidence interval	
00-20	1,277	0,989	1,649	1,145	1,484	1,649	1,059	0,829	1,404	1,100	0,822	1,471
20-40	0,953	0,750	1,211	1,010	1,286	1,211	0,965	0,754	1,235	1,022	0,780	1,338
40-60	ref			ref			ref			ref		
60-80	0,724	**	0,561 0,933	0,862	1,107	0,933	0,666	***	0,535 0,896	0,905	0,690	1,187
80-100	0,662	***	0,500 0,876	0,764	1,008	0,876	0,730	*	0,577 1,015	0,837	0,618	1,135
WOMEN												
Relative income quintile	time t			time t-1			5-year-lag average			10-year-lag average		
	OR	95 % confidence interval		OR	95 % confidence interval		OR	95 % confidence interval		OR	95 % confidence interval	
00-20	1,421	0,914	2,209	1,509	0,956	2,380	2,002	***	1,231 3,257	1,624	*	1,012 2,606
20-40	1,123	0,730	1,728	1,493	0,964	2,311	1,187		0,731 1,926	0,941		0,585 1,513
60-80	0,608	*	0,374 0,987	0,861	0,536	1,384	0,806		0,478 1,360	1,001		0,615 1,632
80-100	0,563	*	0,325 0,973	0,547	*	0,309 0,969	0,702		0,387 1,275	0,620		0,342 1,124

Notes: *** 1%, ** 2.5%, * 5% statistical significance

The advantage that high performing men and women appear to enjoy when relative income and IHD are observed simultaneously vanishes when examining the previous year's relative income. For men, the larger the applied relative income lag, the flatter the IHD-risk gradient becomes. Examining differences in IHD probability between individuals who during the past ten years have had relative incomes less than 51 percent (q1) and those with relative incomes exceeding 151% (q5), the range of odds ratios has decreased to between 1.1 and 0.84. Furthermore, with only one exception, no relative income quintile can be separated from another based on 95% confidence intervals, regardless of the number of relative income lags. The situation when examining men's relative incomes over the preceding five year period represents a curious exception. Here, the top two quintiles are associated with a lower risk of IHD compared to the reference category, a risk which however is not statistically significantly different from the two lowest relative income quintiles. The result nevertheless suggests a potential medium-run response to relative deprivation which favors males with relative incomes exceeding 120 percent.

For women, the pattern is slightly more erratic and linked to the lag structure chosen, with the lowest relative earners being the one group that stands out as suffering from an elevated IHD risk from long-term relative income disadvantage. While not significantly different from the highest relative income earners, at 5 and 10-year-lags, the worst performers experience a significantly elevated IHD risk compared to the reference category (5-year OR: 2.0, 10-year OR: 1.6). Unlike the pattern observed for men, increasing the number of relative income lags does very little to change the overall gradient in IHD risk, expressed by the point estimates. Indeed, the range between the first and the fifth income quintile in terms of odds ratios is bigger at higher lags than at time t . Again, despite the persistence of the relative income gradient, the size of the standard errors however implies that it is impossible to infer that higher relative income earners systematically enjoy significantly lower IHD risks than the lower earners.

Conclusions

The scientific debate regarding the link between socio-economic status and health is likely to remain a central issue for policy makers for years to come. This article represents a contribution to the issue on the generation of socio-economic differences in adult health, explicitly focusing on the link between short and long-term remuneration from work and the risk of IHD. The article has attempted to apply an empirical design which avoids several pitfalls. In doing so, the paper has analyzed the determinants of the first IHD event, combined with examining the influence of earnings that are measured over an extended period of time.

Focusing on the first IHD event among a sizable population of men and women, this study suggests that the link between absolute and relative earnings and the IHD risk observed in previous studies is likely to be over-estimated. By assuming a more long-term perspective, looking at earnings during the preceding five or ten year period does very little or nothing to change this conclusion. The exception to an otherwise consistent pattern is found for women in the lowest relative and income quintile. They experience significantly higher risk despite all included controls, persisting in both the medium and long-term. This would indicate that women who suffer from extreme short-term or long-term economic stress suffer from a de facto increased IHD risks. With the exception of the specification

examining five year relative income lags among males, there are no indications of a similar effect on men.

The results of the paper differ from those of Chaix et al. (2006) who, similar to this paper, look at the individual's long-term earnings, finding a negative relationship between attained income and IHD. The difference in the results is driven by the fact that Chaix et al. (2006) look at IHD mortality, evidently the individual's last IHD event. The negative relationship between income and IHD mortality is likely to be affected by the individual's long-term earnings being affected by IHD-related morbidity occurring well before the fatal event. Sensitivity analyses estimated on the current data support this argument.

A potential limitation of this study pertains to the lack of data on several medical and behavioral conditions, such as drug and alcohol consumption and smoking habits. Should these conditions and habits stay constant over the time of observation, the random effect models will account for differences between the individuals. This is, however, not likely to be the case. Since smoking and bad nutritional habits are more common among socioeconomically disadvantaged individuals, the resulting bias from the failure to account for these characteristics should overestimate the negative relationship between income and IHD risk. It would therefore seem highly unlikely that the virtual inexistent link between absolute and relative income that has been found in this study is masking the existence of a real such relationship.

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Appendix

Table A1: Income/Relative income means for quintiles

Income/Relative income percentile:	0-20	20-40	40-60	60-80	80-100
Income:					
Time t	65681	95218	118465	145881	257519
Time t-1	60476	94367	117303	143955	249740
5-year-lag average	74846	112683	138610	167445	273223
10-year-lag average	65334	100067	122894	147221	230568
Relative income:					
Time t	0.488	0.702	0.858	1.018	1.597
Time t-1	0.454	0.702	0.857	1.015	1.568
5-year-lag average	0.570	0.851	1.025	1.200	1.749
10-year-lag average	0.510	0.773	0.927	1.078	1.514