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Childhood health and labor market outcomes in the case of type 1 diabetes

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Abstract

This study investigates the impact of childhood health on labor market outcomes. We used type 1 diabetes as an instrument of health because its cause is multifactorial and it is triggered by a complex combination of genetic and environmental components; its incidence is low and unforeseeable for the individual; and its onset may be considered an exogenous health shock. Using data from the Swedish Childhood Diabetes Register and national registers on education, employment, and earnings for 2,485 individuals born in 1972–1978 and diagnosed with type 1 diabetes at <15 years old, we found that childhood health impacts on labor market outcomes. The results also imply that causality in the often observed correlation between health and socioeconomic status is partly explained by a gradient that runs from health to earnings, rather than the other way around, which has important implications for policy to reduce socioeconomic-related health inequality.

Keywords: Health, chronic disease, earnings, employment, education
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1. Introduction

Many studies report a strong socioeconomic gradient in health; regardless of the population studied and regardless of how socioeconomic status (SES) and health are measured (Ettner, 1996, Bloom and Canning, 2000, Smith, 1999, Benzeval and Judge, 2001, Gerdtham and Johannesson, 2000, Baum and Ruhm, 2009, Deaton, 2003, Gerdtham and Johannesson, 2002, Gerdtham and Johannesson, 2004, Nordin and Gerdtham, 2013, Gerdtham et al., 2014). Despite improvements in average health status over recent decades, this health–socioeconomic gradient has persisted and even increased in many Western countries (Shkolnikov et al., 2012, van Doorslaer and Koolman, 2004, Mackenbach, 2005). It has recently been suggested that socioeconomic inequality has to be reduced in order to reduce the socioeconomic gradient in health (Marmot et al., 2010). This suggestion is, however, based on the foregone conclusion that the gradient in health reflects causal effects running from the former to the latter. There is little general agreement on this assumption, and a debate has evolved (Smith, 1999, Deaton, 2011). Two main issues underlie the disagreement on causation: (1) causality may run from health to SES rather than the other way around, as has been argued by Gerdtham et al. (2014), Lundborg et al. (2014) and Currie et al. (2010) among others; and (2) there may be some third,

unobserved factor, which may explain the observed relationship between health and SES. Consequently, empirical associations between health and SES may not necessarily result from a causal mechanism. It is not possible to conclude from cross-sectional data which of these alternative hypothesis carry the greatest weight. However, longitudinal data and information on early life events may hold necessary characteristics to disentangle these potential pathways.

This paper contributes to the literature on the relationship between childhood health and SES by exploring labor market consequences of childhood health using unique data from the Swedish Childhood Diabetes Register (SCDR). The paper sheds further light on the complexity of the relationship between SES and health in that it reveals a causal mechanism from childhood health to labor market outcomes, which is interesting both in its own right and from a health policy perspective.

To reveal the causal effect of childhood health on labor market outcomes, we use the onset of type 1 diabetes (T1DM) as an instrument for childhood health. The reasoning was that T1DM, due to its specific etiology, may be viewed as an exogenous health shock that the child and his or her parents are unable to anticipate or influence in advance. The exogeneity enables more straightforward methods when analyzing the impact of health shocks on labor market outcomes, compared to previous research in this area. This is the first national register study exploring labor market consequences of health shocks in childhood using the impact of T1DM. In addition, we also studied potential mechanisms through which childhood health may affect different labor market outcomes.

The paper is organized as follows: in Section 2, we present previous research on the effect of childhood health shocks on SES together with background information about T1DM with focus on the etiology of the disease. In Section 3, the data and statistical approach are described and

in Section 4, we present the regression results from the key variables of interest. Finally, in Section 5, we discuss the results and conclude the paper.

2. Background

2.1. Previous research

The effect of health on labor market outcomes has been widely studied in both the medical and the economic literature. In a review, Currie and Madrian (1999) found empirical evidence suggesting that health has a pervasive effect on a wide range of labor market outcomes. However, there was no consensus about the magnitude of the effect and the results were not robust to the measure of health. Furthermore, several studies ignored the endogeneity issue associated with the chosen measure of health or relied on less justifiable exclusion restrictions. It is also not clear from the literature to what extent the effect on labor market outcomes reflects a productivity or discrimination effect (Dackenhag et al., 2014).

More recently published studies provide evidence of the impact of nutritional status, such as birth weight, height, or body mass index, on future labor market outcomes (Case and Paxson, 2010b, Case et al., 2005, Currie and Hyson, 1999). Haas et al. (2011) and Smith (2009) used self-reported retrospective measures of childhood health, whereas Currie et al. (2010) and Lundborg et al. (2014) used specific health conditions, such as asthma, injuries, and congenital anomalies.

Most of the health measures used in the previous literature are associated with issues of endogeneity as the mechanisms behind ill health may also impact SES. A common approach to adjust for this potential bias is the fixed effects approach using sibling or twin data to deal with potential omitted variable bias at the family level. The effect of diminished health may, however, be underestimated using this approach if family resources are strained by the ill health of the child, as both time and financial resources may be needed to manage the disease.

Furthermore, the generalizability of twin studies is sometimes questioned (Barnes and Boutwell, 2013).

Few studies use diabetes as a measure of ill health and those that do, focus on the more common type 2 diabetes (T2DM) or do not distinguish between the two types, which differ in several important aspects, particularly concerning the cause of the onset (Case and Paxson, 2010a, Haas et al., 2011, Maslow et al., 2011, Tunceli et al., 2005, Bastida and Pagan, 2002, Brown et al., 2011, Fletcher and Richards, 2012, Brown et al., 2005). Brown et al. (2005), estimated the impact of diabetes on labor market outcomes using family history of diabetes as an instrument to correct for potential endogeneity bias. This strategy may, however, introduce bias in itself if the family history of diabetes has had a direct effect on employment.

The literature focusing on the labor market impact of T1DM specifically is very limited. In a review, Milton et al. (2006) found that people with childhood onset T1DM appear to experience disadvantages on the labor market in adulthood. The included studies typically analyzed small samples and lacked longitudinal data, and only one was published after year 2000. Using data from the Diabetes Incidence Study in Sweden (DISS), Steen Carlsson et al. (2010) found that the onset of T1DM in (young) adulthood (at 15–34 years) resulted in long-term consequences on earnings for women (-8%) and men (-4%). Minor (2011) estimated the impact of T1DM and T2DM separately, concluding that much of the negative labor market effect among women was due to T2DM. In a later publication, Minor (2013) found that both employment and wages were negatively related to diabetes duration. Both studies used survey data with a self-reported incidence of diabetes. As the data did not distinguish between T1DM and T2DM, all respondents diagnosed before the age of 20 were considered to have T1DM, resulting in a sample of about 60 and 350 individuals in the two studies, respectively.

To our knowledge, there are no published studies exploring labor market consequences of childhood onset T1DM using national register data. A few studies, however, have investigated the impact of childhood onset T1DM on schooling and educational attainment in Sweden (Dahlquist and Källén, 2007, Persson et al., 2013, Wennick et al., 2011). Persson et al. (2013) found a small, but statistically significant, negative effect of T1DM on school grades from compulsory and upper secondary school among children born in 1972–1978, the cohort used in this study.

2.2. Possible mechanisms behind the impact of type 1 diabetes mellitus on labor market outcomes

In the well-known theoretical framework of the Grossman demand for health model, health is considered both a consumption good generating direct utility from being healthy, and an investment good, generating utility indirectly through more healthy time available for work and educational investments (Grossman, 1972). This framework implies that a health shock in childhood, such as T1DM, would impact the individual in two main ways. The first is through its impact on educational prospects as health is considered a key input into human capital accumulation. Additionally, increased uncertainty about future health, labor market productivity, and life expectancy may reduce incentives to invest in higher education implying dynamic negative effects on career opportunities. The second way is through the impact of increased absenteeism and reduced work capacity due to ill health in adulthood as a result of short- and long-term diabetic complications.

2.3. Type 1 diabetes mellitus – an exogenous health shock?

T1DM is a chronic, autoimmune, disorder which destroys the insulin-producing beta cells in the pancreas and thereby the body's ability to regulate blood glucose levels. It accounts for about 5–10% of all cases of diabetes (Daneman, 2006) and has been called juvenile onset

diabetes as the onset often occurs in childhood or early adolescence. To keep the levels of blood glucose within a target range, the disease requires lifelong, daily treatment including monitoring of blood glucose levels and injections of insulin, as well as strict routines concerning food and exercise. T1DM is associated with both short- and long-term diabetic complications, including hypoglycemia, cardiovascular disease, and nerve, kidney, and eye disease. Consequently, T1DM may put great strain on the affected individuals and their families.

The exact cause of T1DM is still unknown, but current evidence suggests that the onset is multifactorial, triggered by a complex combination of both genetic and environmental components. Heredity of the disease is low; earlier results from the SCDR show that >90% of the T1DM onset occur among individuals without an affected first degree relative (parent or sibling) (Dahlquist et al., 1989). Furthermore, the incidence is known to vary by geography, and over time within countries, suggesting that environmental factors could be of importance (Patterson et al., 2009, Soltesz et al., 2007); however, no single environmental factor has been found to be associated with the onset. Some viruses and perinatal events may also be associated with increased risk in early childhood (Dahlquist et al., 1999) and later in life, rapid increase in height may possibly accelerate the risk of disease onset at puberty (Dahlquist, 2006). Each of these factors may contribute to a small part of the total risk, but the individual needs to be exposed to several of these in a certain sequence and during a vulnerable time period, for the onset of the disease to be triggered. Due to this etiology of T1DM, we believe that it is reasonable to treat T1DM onset as an exogenous health shock, which the individual is unable to influence through actions or anticipate beforehand. Consequently, we expect any systematic differences concerning socioeconomic and other background characteristics between individuals with and without T1DM to be small, if present at all.

3. Method

3.1. Data

In the analysis, we used unique data from the SCDR, a Swedish national research register for incident cases of T1DM younger than 15 years that have been prospectively recorded since 1977. To enable the analysis of socioeconomic factors, the SCDR has been linked using the individual identification number, to the following national registers and databases: the Multi-Generation Register (Statistics Sweden, 2010), the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) (Statistics Sweden, 2011), the Swedish Medical Birth Register (Centre for Epidemiology, 2003), and the Swedish Register of Education (Statistics Sweden, 2006).

Since the mean yearly incidence of T1DM is low (44/100,000 children aged 0–14 in Sweden 2005–2007 (Berhan et al., 2011)), a matching procedure has been used to create a manageable comparison group for the study.¹ For each person registered in the SCDR, Statistics Sweden selected four non-diabetic individuals from the Register of the Total Population, matched for year of birth and municipality of residence at the time of the T1DM diagnosis. Using the Multi-Generation Register, the parents of the children with T1DM and the comparison group were identified.²

For this study, we selected individuals born in Sweden in 1972–1978 (total n=12,425; T1DM group: n=2,485; comparison group: n=9,940). Variables of annual earnings and highest educational degree were available from the LISA database 1990–2010 and we followed the full

¹An alternative method would have been to use data on all individuals in the Swedish population born in the same year. This method would, however, have resulted in a considerably large comparison group as the individuals registered in the SCDR were born in 1962–2010. Connecting data also for their parents, the resulting data set would have included most of the Swedish population, which may have been difficult for ethical reasons; furthermore, the gain in bias reduction would have been marginal.

²Data linkage was performed by Statistics Sweden and only anonymous data was returned to the researchers for analysis. The study was approved by the Regional Research Ethics Board in Umeå (Dnr 07-169M).

study population for 14 years: from age 19 (the standard age for graduating from upper secondary school in Sweden) through age 32 years.

Panel attrition from mortality before age 33 was 1.2% on average (T1DM 76 (3.1%); comparators 92 (0.9%)). The analysis was based on 2,409 people with T1DM and 9,848 comparators (total n=12,257). The final data set is an unbalanced panel including an average of 13.7 annual observations (range 1–14 years).

3.2. The study sample

Summary statistics of key variables are presented separately for women and men in Table 1. At the age of 32, the proportion of individuals with a university degree was slightly smaller and the average number of years of schooling was slightly lower in the T1DM group.³ A smaller proportion of women with T1DM were employed and annual earnings if employed were on average lower for men and women with T1DM.⁴ A slightly smaller proportion at the age of 32 had children in the household.

Measures of socioeconomic background, parents' educational level⁵, and earnings⁶ did not differ significantly between the two groups. The proportion of individuals with a parent born in a non-Nordic country and the proportion with missing information on the parents' educational level was slightly smaller in the T1DM group.

³ The numerical variable of total years of schooling was calculated based on the categorical variable of highest attained educational level in the LISA data (Statistics Sweden, 2011) using the same algorithm as used in Gerdtham et al (2014).

⁴Employment is defined by the employment status in November each year and annual earnings indexed to the year 2010 using the consumer price index and translated in to Euros (EUR 1 = SEK 9.5413 in 2010 The Swedish Central Bank (The Swedish Central Bank, 2010)

⁵Parents' educational level was defined by highest attained education, where low = compulsory, medium = upper secondary, high = university education; or the value is given as 'missing'.

⁶The parents' earnings were defined as mean annual earnings for 1990–2010, indexed to year 2010 using the consumer price index (Statistics Sweden, 2014).

3.3. Graphical illustration of annual earnings

In Figure 1, we graphically illustrate the development of annual earnings (using first, second (median), and third quartiles) from 19 to 32 years of age in the T1DM group and the comparison group separately. Before the age of 27, men with T1DM had similar or slightly higher earnings, but thereafter they started lagging behind, as seen in all quartiles. Women with T1DM had lower earnings throughout the whole period, at least in the first and second quartiles, with a larger gap after the age of 25. Figure 2 shows the development of annual earnings for men and women by educational status at the age of 32. The largest gap between the groups, throughout the follow-up period, is seen between people without university education. During the first 9 years of the observation period (ages 19–27 years), university-educated men with T1DM had higher earnings compared to the comparison group, perhaps a consequence of entering the labor market earlier after graduating from shorter university programs.

3.4. Statistical methods

We explored the impact of T1DM on labor market outcomes from 19–32 years of age using random effect panel data regression to assess the differences between the T1DM group and the comparison group, treating the onset of T1DM as an exogenous health shock. For our purposes, the alternative approach using a fixed effect model would not have been suitable as it would not have allowed us to assess effects of variables that do not vary over time, which is the case in our study as the explanatory variable of interest (T1DM) is time-invariant in our data examining early adulthood while the onset of T1DM occurred before age 15 years.

Consequently, we first assessed the impact of T1DM on employment using a logistic random effects model. Next, we assessed the impact of T1DM on annual earnings including only observations from years when the individuals were employed. We used the following basic model specification (Model 1):

$$y_{it} = \alpha + \beta_{Diabetes} * Diabetes_i + u_i + \varepsilon_{it} \quad (1)$$

where the dependent variable y (either a dummy for employment or the natural logarithm of annual earnings) for individual i at age t is a function of the time-invariant dummy variable of having T1DM. α is the intercept, u_i is the time-invariant, individual level effect, and ε_{it} is the individual time-specific error term. As the onset of T1DM in all relevant aspects is close to an exogenous random health shock, we expect u_i to be uncorrelated with the regressors in the model. The individual level effect can then be viewed as additional disturbance in the model.

Additionally, to test the robustness of the results and increase the explanatory power, we extended the model by including a set of time-invariant covariates (X) of demographic and socioeconomic background (a measure of permanent income⁷ and educational level of the mother and father, and whether the parents were born in a non-Nordic country), that are likely to impact on the two outcome variables; employment and earnings. We also controlled for a potential time trend by including year specific dummy variables (Model 2).

$$y_{it} = \alpha + \beta_{Diabetes} * Diabetes_i + \beta_X * X_i + \sum \beta_{Year} * DummyYear_{it} + u_i + \varepsilon_{it} \quad (2)$$

In addition, we added two sets of covariates potentially associated with labor market activity: the subject's own educational status (compulsory, upper secondary, or university education) (Model 3, not shown) and having children (Model 4, not shown). In Model 5 (not shown), we investigated the impact of T1DM duration by including dummy variables representing years since disease onset, measured in 3-year intervals. As all individuals were diagnosed before the age of 15, the minimum number for T1DM duration was 4 years at the age of 19. The first and the last dummy (4–9 years and 25–32 years) contained wider time intervals to include a sufficient number of observations. Finally, we ran Model 1 and 2 separately in two subgroups,

⁷ Defined as the average income during 1990–2010.

19–26 and 27–32 year-olds, to compare the impact of T1DM earlier and later in young adulthood.

As education is a potentially important mechanism through which childhood onset T1DM could impact labor market outcomes, we further investigated this parameter by performing separate analyses of the educational impact of T1DM at the age of 32 years. Ordinary Least Squares (OLS) regression was used to study the impact on the total number of years of education, and logistic regression was used to study the impact on the probability of having a university degree.⁸

4. Results

In Section 4.1, we present the results from the analysis of employment and earnings, first at 19–32 years of age, using Models 1–5. Thereafter, we present the results from Model 1 and 2 separately for the time period before and after the age of 26 years. Finally, section 4.2 reports the results from the analysis on educational attainment, both defined as years of education and as the likelihood of attaining a university degree.

4.1. Employment and annual earnings

Tables 2 and 3 show the total impact of T1DM on employment and earnings in the time period between the ages of 19 and 32 years. Women with T1DM were less likely to be employed (odds ratio (OR) 0.841; 95% confidence interval (CI) 0.756–0.934) and those employed on average had 5.5% ($p=0.001$) lower earnings compared to the comparison group (Model 1, Table 2). Similar results were reported in Model 2, adjusting for demographic and socioeconomic background. As information about socioeconomic background was missing for 379 (6.2%) women, the sample included in the adjusted model was slightly smaller. Using this slightly

⁸ All analyses were performed using Stata version 13 (StataCorp, 2013).

reduced sample for Model 1 gave practically identical results. Adjusting also for the potentially mediating mechanisms, education (Model 3) only slightly reduced the direct impact whereas having had children (Model 4) appeared to have no effect on the results, suggesting that other aspects of the disease may hamper career opportunities. Overall the results from the four models were similar among women. When analyzing the impact of T1DM duration (Model 5), the impact on employment and earnings tended to increase slightly with time since onset of the disease.

Unlike the results for women, no statistically significant effect on employment was seen among men during the full study period in any of the models, except for after more than 22 years of T1DM duration (Model 5, Table 3). Earnings were, however, about 3% lower among those with T1DM who were employed (Models 1–4) and a clear increasing trend could be seen with disease duration. The impact on earnings was statistically significant after 19–21 years of T1DM (6.8% lower, $p < 0.001$) and increased to 16.3% ($p < 0.001$) lower earnings after 25–32 years. For full regression results for Models 2–4, see the Appendix, Tables A1–A4.

Tables 4 and 5 show the impact of T1DM among women and men on employment and earnings when splitting the period into early and late young adulthood (19–26 and 27–32 years, respectively). As expected from the graphical analysis, no statistically significant impact was seen at first (19–26 years) among women (Table 4). However, later in young adulthood, the impact increased considerably (OR of employment 0.564; 95% CI 0.451–0.706, and 9.1% lower earnings ($p < 0.001$), Model 1). For men, T1DM in early young adulthood was even associated with a positive impact on employment and earnings, at least in the unadjusted model (OR of employment 1.186; 95% CI 1.055–1.338; and 3% higher earnings ($p = 0.028$), Model 1, Table 5). After age 27 years, the impact of T1DM was, however, negative also for men. To test if the impact of T1DM differed depending on educational level we ran Model 3 in the older sample, including also interactions between T1DM and level of education. The results showed

a potential tendency towards a larger impact of T1DM among individuals with lower levels of education, but with overlapping CIs.

We believe that the difference in the results between early and later young adulthood is, to a great extent, related to the difference in time spent on university education during this period. In early young adulthood, significant proportions of each birth cohort have not yet entered the labor market due to higher education or for other reasons. Later on, with increasing proportions of each birth cohort searching and finding jobs, the benefits of longer education may start to show, suggesting that the results from the later period are more relevant for predicting the impact of T1DM beyond the age of 32 years.

4.2. Educational level

Table 6 presents the results of the analyses of highest educational level, performed to further investigate education as a potential mechanism through which T1DM could be impacting earnings. Although the impact of T1DM changed very little when adjusting for educational level in the regression model for earnings, a negative impact of T1DM could be seen on the total number of years of education (women: -0.264 ($p < 0.001$); and men: and -0.178 ($p = 0.009$) years, Model 1, first column). For women, this would be equivalent to about 1 year less education among one out of four individuals in the T1DM group. The impact was stable and changed very little when using the adjusted model (Model 2).

We also studied the impact of T1DM on the likelihood of having a university degree. The results showed that both men and women with T1DM are less likely to have a university degree (women: OR 0.806; 95% CI 0.707–0.920; and men: OR 0.843; 95% CI 0.738–0.962, Model 1). The impact was slightly larger using the adjusted model (Model 2) with a small shift in the CI. Similar results were found when investigating the probability of attaining a ≥ 3 year university

degree (women: OR 0.802; 95% CI 0.700–0.921; and men: OR 0.833; 95% CI 0.717–0.968, Model 1). The full regression results can be found in the Appendix, Table A5.

5. Discussion and Conclusion

This study investigates the impact of a childhood health shock on labor market outcomes among young adults using the onset of T1DM in childhood as an instrument of an exogenous health shock that provides a distinct and definable reduction in the health of the child requiring daily, lifelong self-management. The results show that T1DM negatively impacts the level of education and labor market outcomes among young adults, which is particularly visible later on (in this study after the age of 26 years) when benefits from educational investments are more apparent. Similar effects of T1DM were found for both men and women at the age of 27–32 years, but among women, the effect appeared in younger ages. For men, however, the effect tended to increase more with the duration of the disease. Throughout the analysis, the results were robust to changes in the model specification used.

One limitation of the study is that our data allowed us to explore the labor market impact of T1DM for young adults up to the age of 32 years, that is, the early years of the labor market career. Data with longer follow-up was, for obvious reasons, not yet available yet for this group of individuals born in 1972–1978. Nevertheless, a longer follow-up period may in future research be used to explore how these early differences continue at an older age.

In a simple illustrative calculation, we can approximate the lifetime penalty of having T1DM on earnings. If we assume that the impact of T1DM remains constant as people age (8% and 9% lower for men and women, respectively) and if we further assume average earnings of EUR39,400 and EUR30,000 per year for employed men and women, respectively (Statistics Sweden, 2012), over a 40 year working life, we can estimate a total impact of around EUR126,000 and EUR108,000 for men and women, respectively. In a societal perspective, this

translates to more than 5 billion Euros assuming that the number of affected persons with T1DM in Sweden remains around 50,000 individuals. This impact would be larger if we also included earnings lost due to unemployment and long-term complications of the disease.

So what specific factors associated with childhood onset T1DM may be driving the negative impact on labor market outcomes shown in this study? Previous studies have found evidence of a negative impact of T1DM on schooling and level of education (Persson et al., 2013, Dahlquist and Kallen, 2007, Hannonen et al., 2010, Wennick et al., 2011) and the results from this study provide further evidence that the disease impacts both the total number of years of education and the likelihood of attaining university education. As the positive relationship between education and labor market status is well known and documented in the literature of human capital (Goldberg and Smith, 2007, Card, 1999), it seems logical to suspect that the labor market effect of T1DM is driven by its effect on education. Nevertheless, including level of education in the regression model increased the goodness of fit but decreased the estimated effect of T1DM very slightly, indicating that the greatest part of the impact is not related to differences in education.

The majority of the impact on employment and earnings is therefore likely to be more directly associated with other aspects of the disease. Management of T1DM can be time-consuming and may decrease flexibility in daily activities (Sparud-Lundin et al., 2013). Furthermore, short- and long-term, diabetes-related complications may increase absenteeism and reduce work capacity. If diabetic complications drive the impact of T1DM on labor market status, then the impact is likely to increase over time as the prevalence of complications is known to increase with disease duration. At the age of 32, the people in our sample had lived with T1DM for 17–32 years and may have experienced initial stages of diabetic complications. For example, according to The Swedish National Diabetes Register (2014), the prevalence of diabetic retinopathy (early stage of eye disease) and albuminuria (early stage of limitations in kidney

function) among 32-year-old individuals with T1DM in Sweden in 2010, the last year of our study data, was 62% and 14%, respectively. In the same year, the prevalence of these two complications among 52-year-olds with the disease was 73% and 27%, respectively. The fact that our results show an increasing tendency of negative effect with the disease duration further supports this hypothesis.

The development of complications is, however, related not only to duration, but also to disease management including control of risk factor development, notably blood glucose control. Stable blood glucose levels have been associated with postponed development of diabetic complications (The Diabetes Control and Complications Trial Research Group, 1993). This means that if the negative impact of T1DM is associated with complications, then the development of more enhanced treatment strategies may be an efficient way of limiting the labor market consequences of T1DM in the future. The data needed to explore the impact of diabetes-related complications was, however, not available for this study.

In conclusion, the findings from this study suggest that (1) an exogenous health shock early in life, which introduces demands of daily disease management, can translate into lower education, lower employment, and reduced earnings at a group level; and (2) the impact of T1DM remained stable through a number of specifications of the empirical estimation model leaving little room for systematic bias. Our results add to the literature on causality issues surrounding health and socio-economic outcomes and provide measures of the size of the effect of health on education, employment, and earnings.

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References

- BARNES, J. C. & BOUTWELL, B. B. 2013. A demonstration of the generalizability of twin-based research on antisocial behavior. *Behav Genet*, 43, 120-31.
- BASTIDA, E. & PAGAN, J. A. 2002. The impact of diabetes on adult employment and earnings of Mexican Americans: findings from a community based study. *Health economics*, 11, 403-13.
- BAUM, C. L., 2ND & RUHM, C. J. 2009. Age, socioeconomic status and obesity growth. *J Health Econ*, 28, 635-48.
- BENZEVAL, M. & JUDGE, K. 2001. Income and health: the time dimension. *Soc Sci Med*, 52, 1371-90.
- BERHAN, Y., WAERNBAUM, I., LIND, T., MOLLSTEN, A. & DAHLQUIST, G. 2011. Thirty years of prospective nationwide incidence of childhood type 1 diabetes: the accelerating increase by time tends to level off in Sweden. *Diabetes*, 60, 577-81.
- BLOOM, D. E. & CANNING, D. 2000. Policy forum: public health. The health and wealth of nations. *Science*, 287, 1207, 1209.
- BROWN, H. S., 3RD, PAGAN, J. A. & BASTIDA, E. 2005. The impact of diabetes on employment: genetic IVs in a bivariate probit. *Health economics*, 14, 537-44.
- BROWN, I. I. I. H., PEREZ, A., YARNELL, L. M., PAGAN, J. A., HANIS, C. L., FISCHER-HOCH, S. P. & MCCORMICK, J. B. 2011. Diabetes and employment productivity: does diabetes management matter? *The American journal of managed care*, 17, 569-76.
- CARD, D. 1999. The Causal Effect of Education on Earnings *Handbook of Labor Economics*, 3, 1801-1863.
- CASE, A., FERTIG, A. & PAXSON, C. 2005. The lasting impact of childhood health and circumstance. *Journal of Health Economics*, 24, 365-389.
- CASE, A. & PAXSON, C. 2010a. Causes and consequences of early-life health. *Demography*, 47 Suppl, S65-85.
- CASE, A. & PAXSON, C. 2010b. Causes and consequences of early-life health. *Demography*, 47, S65-S85.
- CENTRE FOR EPIDEMIOLOGY 2003. The Swedish Medical Birth Register - A summary of content and quality.
- CURRIE, J. & HYSON, R. 1999. Is the Impact of Health Shocks Cushioned by Socioeconomic Status? The Case of Low Birthweight. *American Economic Review*, 89, 245-250.
- CURRIE, J. & MADRIAN, B. C. 1999. *Health, Health Insurance and the Labour Market*, Elsevier Science B.V.
- CURRIE, J., STABILE, M., MANIVONG, P. & ROOS, L. L. 2010. Child Health and Young Adult Outcomes. *Journal of Human Resources*, 45, 517-548.
- DACKENHAG, M., GERDTHAM, U.-G. & NORDIN, M. 2014. Productivity or discrimination? An economic analysis of excess-weight penalty in the Swedish labor market. *European Journal of Health Economics*, In Press.
- DAHLQUIST, G. 2006. Can we slow the rising incidence of childhood-onset autoimmune diabetes? The overload hypothesis. *Diabetologia*, 49, 20-24.
- DAHLQUIST, G., BLOM, L., TUVEMO, T., NYSTRÖM, L., SANDSTRÖM, A. & WALL, S. 1989. The Swedish childhood diabetes study — results from a nine year case register and a one year case-referent study indicating that Type 1 (insulin-dependent) diabetes mellitus is associated with both Type 2 (non-insulin-dependent) diabetes mellitus and autoimmune disorders. *Diabetologia*, 32, 2-6.

- DAHLQUIST, G. & KALLEN, B. 2007. School performance in children with type 1 diabetes--a population-based register study. *Diabetologia*, 50, 957-64.
- DAHLQUIST, G. G., PATTERSON, C. & SOLTESZ, G. 1999. Perinatal risk factors for childhood type 1 diabetes in Europe. The EURODIAB Substudy 2 Study Group. *Diabetes Care*, 22, 1698-702.
- DANEMAN, D. 2006. Type 1 diabetes. *The Lancet*, 367, 847-858.
- DEATON, A. 2003. Health, inequality, and economic development. *Journal of Economic Literature* XLI, 113-158.
- DEATON, A. 2011. What does the empirical evidence tell us about the injustice of health inequalities. Center for Health and Wellbeing, Working Paper, Princeton University, January.
- ETTNER, S. L. 1996. New evidence on the relationship between income and health. *J Health Econ*, 15, 67-85.
- FLETCHER, J. M. & RICHARDS, M. R. 2012. Diabetes's 'health shock' to schooling and earnings: increased dropout rates and lower wages and employment in young adults. *Health Aff (Millwood)*, 31, 27-34.
- GERDTHAM, U.-G. & JOHANNESSON, M. 2002. Do Life-Saving Regulations Save Lives? *Journal of Risk and Uncertainty*, 24, 231-249.
- GERDTHAM, U.-G. & JOHANNESSON, M. A. I., RELATIVE INCOME, INCOME INEQUALITY AND MORTALITY? JOURNAL OF HUMAN RESOURCES, 39: 228-247 2004. Absolute Income, Relative Income, Income Inequality and Mortality? *Journal of Human Resources*, 39, 228-247
- GERDTHAM, U.-G., LUNDBORG, P., LYTTKENS, C. H. & NYSTEDT, P. 2014. Do Education and Income Really Explain Inequalities in Health? Applying a Twin Design. *Scandinavian Journal of Economics*, In Press.
- GERDTHAM, U. G. & JOHANNESSON, M. 2000. Income-related inequality in life-years and quality-adjusted life-years. *J Health Econ*, 19, 1007-26.
- GOLDBERG, J. & SMITH, J. 2007. The effects of education on labor market outcomes. *Handbook of research in education finance and policy*, New York, NY: Routledge, 688-708.
- GROSSMAN, M. 1972. On the Concept of Health Capital and the Demand for Health. *The Journal of Political Economy*, 80, 223-255.
- HAAS, S. A., GLYMOUR, M. M. & BERKMAN, L. F. 2011. Childhood health and labor market inequality over the life course. *J Health Soc Behav*, 52, 298-313.
- HANNONEN, R., KOMULAINEN, J., EKLUND, K., TOLVANEN, A., RIIKONEN, R. & AHONEN, T. 2010. Verbal and academic skills in children with early-onset type 1 diabetes. *Developmental Medicine & Child Neurology*, 52, e143-e147.
- LUNDBORG, P., NILSSON, A. & ROTH, D. O. 2014. Adolescent health and adult labor market outcomes. *J Health Econ*, 37, 25-40.
- MACKENBACH, J. 2005. Trends in socio-economic inequalities in self-assessed health in 10 European countries. *International Journal of Epidemiology*, 295-305.
- MARMOT, M., ALLEN, J., GOLDBLATT, P., BOYCE, T., MCNEISH, D., GRADY, M. & GEDDES, I. 2010. Fair society, healthy lives: the Marmot review – strategic review of health inequalities in England post-2010. London: University College London.
- MASLOW, G. R., HAYDON, A., MCREE, A. L., FORD, C. A. & HALPERN, C. T. 2011. Growing up with a chronic illness: social success, educational/vocational distress. *J Adolesc Health*, 49, 206-12.
- MILTON, B., HOLLAND, P. & WHITEHEAD, M. 2006. The social and economic consequences of childhood-onset Type 1 diabetes mellitus across the lifecourse: a systematic review. *Diabetic Medicine*, 23, 821-829.

- MINOR, T. 2011. The effect of diabetes on female labor force decisions: new evidence from the National Health Interview Survey. *Health economics*, 20, 1468-86.
- MINOR, T. 2013. An investigation into the effect of type I and type II diabetes duration on employment and wages. *Econ Hum Biol*, 11, 534-44.
- NORDIN, M. & GERDTHAM, U.-G. 2013. Why a positive link between age and income-related health inequality. *Nordic Journal of Health Economics*. *In Press*.
- PATTERSON, C. C., DAHLQUIST, G. G., GYURUS, E., GREEN, A., SOLTESZ, G. & GROUP, E. S. 2009. Incidence trends for childhood type 1 diabetes in Europe during 1989-2003 and predicted new cases 2005-20: a multicentre prospective registration study. *Lancet*, 373, 2027-33.
- PERSSON, S., DAHLQUIST, G., GERDTHAM, U. G. & STEEN CARLSSON, K. 2013. Impact of childhood-onset type 1 diabetes on schooling: a population-based register study. *Diabetologia*, 56, 1254-62.
- SHKOLNIKOV, V. M., ANDREEV, E. M., JDANOV, D. A., JASILIONIS, D., KRAVDAL, O., VAGERO, D. & VALKONEN, T. 2012. Increasing absolute mortality disparities by education in Finland, Norway and Sweden, 1971-2000. *J Epidemiol Community Health*, 66, 372-8.
- SMITH, J. P. 1999. Healthy bodies and thick wallets: the dual relation between health and economic status. *J Econ Perspect*, 13, 144-66.
- SMITH, J. P. 2009. The Impact of Childhood Health on Adult Labor Market Outcomes. *Review of Economics and Statistics*, 91, 478-489.
- SOLTESZ, G., PATTERSON, C. C. & DAHLQUIST, G. 2007. Worldwide childhood type 1 diabetes incidence--what can we learn from epidemiology? *Pediatr Diabetes*, 8 Suppl 6, 6-14.
- SPARUD-LUNDIN, C., HALLSTROM, I. & ERLANDSSON, L. K. 2013. Challenges, strategies, and gender relations among parents of children recently diagnosed with type 1 diabetes. *J Fam Nurs*, 19, 249-73.
- STATA CORP 2013. *Stata Statistical Software: Release 13*, College Station, TX: StataCorp LP.
- STATISTIC SWEDEN 2014. Konsumentprisindex (KPI). Online Database. Accessed; 2013-10-01.
- STATISTICS SWEDEN 2006. Evaluation of the Swedish Register of Education.
- STATISTICS SWEDEN 2010. Multi-Generation Register 2009 - A description of contents and quality. *Population and Welfare Statistics 2010:3*.
- STATISTICS SWEDEN 2011. Longitudinell integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) 1990-2009. *Arbetsmarknads- och utbildningsstatistik 2011:4*.
- STATISTICS SWEDEN 2012. Sammanräknad förvärvsinkomst 2012 [Total income 2012]. Online Database. Accessed; 2014-01-30.
- STEEN CARLSSON, K., LANDIN-OLSSON, M., NYSTROM, L., ARNQVIST, H. J., BOLINDER, J., OSTMAN, J. & GUDBJORNSDOTTIR, S. 2010. Long-term detrimental consequences of the onset of type 1 diabetes on annual earnings-evidence from annual registry data in 1990-2005. *Diabetologia*, 53, 1084-92.
- THE DIABETES CONTROL AND COMPLICATIONS TRIAL RESEARCH GROUP 1993. The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus. *New England Journal of Medicine*, 329, 977-986.
- THE SWEDISH CENTRAL BANK (The Swedish Central Bank (Sveriges riksbank)) 2010. Search interest & exchange rates. Online Database. Accessed; 2013-10-01.

- THE SWEDISH NATIONAL DIABETES REGISTER 2014. ndr.nu. Online Database. Accessed; 2014-08-11.
- TUNCELI, K., BRADLEY, C. J., NERENZ, D., WILLIAMS, L. K., PLADEVALL, M. & ELSTON LAFATA, J. 2005. The impact of diabetes on employment and work productivity. *Diabetes care*, 28, 2662-7.
- VAN DOORSLAER, E. & KOOLMAN, X. 2004. Explaining the differences in income-related health inequalities across European countries. *Health Econ*, 13, 609-28.
- WENNICK, A., HALLSTROM, I., LINDGREN, B. & BOLIN, K. 2011. Attained education and self-assessed health later in life when diagnosed with diabetes in childhood: a population-based study. *Pediatr Diabetes*, 12, 619-26.

Figures 1–2

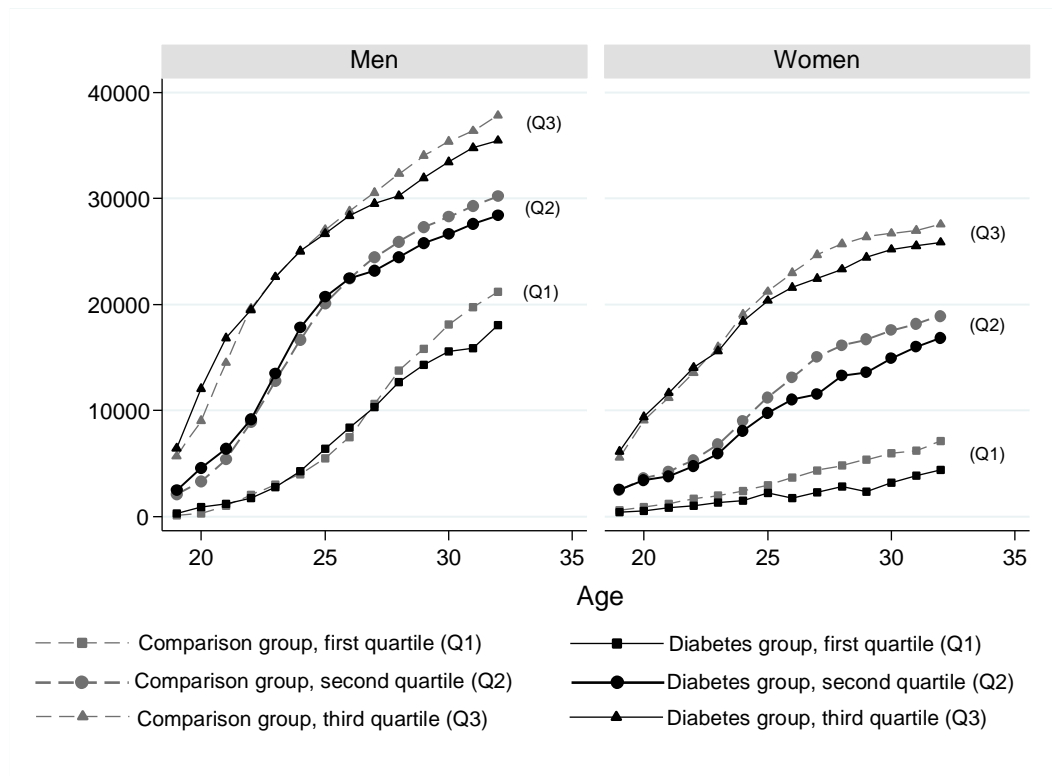


Figure 1: Development of annual earnings for the T1DM group and the comparison group, from the age of 19 to 32 years.

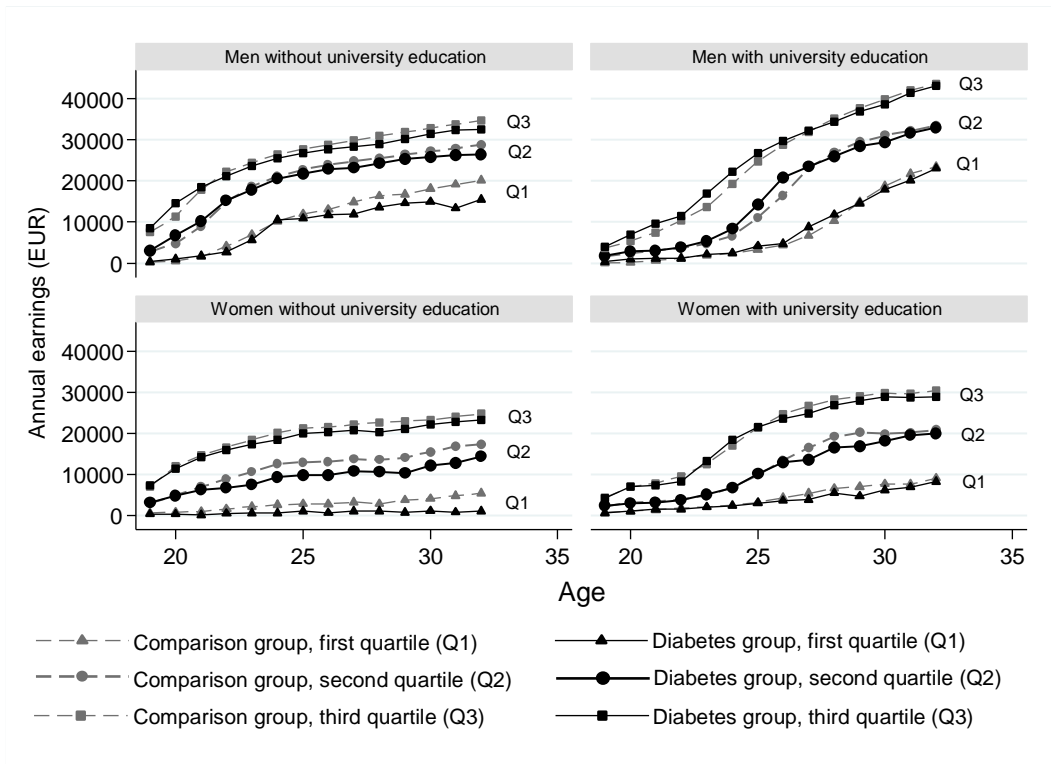


Figure 2: Development of annual earnings for the T1DM group and the comparison group, from the age of 19 to 32 years, by gender and education at the age of 32

Tables 1–6

Table 1: Summary statistics for the type 1 diabetes mellitus (T1DM) group and the comparison group at the age of 32 years

	Women (n=6,152)			Men (n=6,105)		
	T1DM (n=1,141)	Comparators (n=5,011)	p value ^a	T1DM (n=1,268)	Comparators (n=4,837)	p value ^a
Birth year	1975	1975	0.378	1975	1975	0.272
Age at diagnosis (years)	9.34	–		9.59	–	
Educational level at age 32						
• Compulsory schooling	0.07	0.06	0.144	0.10	0.10	0.379
• Upper secondary school	0.47	0.43	0.009	0.54	0.50	0.040
• University	0.46	0.51	0.001	0.33	0.36	0.016
• Missing data	0.03	0.06	<0.001	0.04	0.04	0.490
Years of schooling at age 32 ^b	12.92	13.18	<0.001	12.45	12.63	0.009
Employed (in November) ^c	0.80	0.86	<0.001	0.88	0.86	0.070
Earnings if employed (annual mean, EUR) ^d	20,506	21,844	0.006	30,844	33,027	<0.001
Children (1=yes)	0.65	0.68	0.047	0.47	0.51	0.053
• 0–3 years old	0.48	0.57	<0.001	0.38	0.43	0.001
• 4–6 years old	0.28	0.31	0.046	0.16	0.18	0.070
• 7–10 years old	0.23	0.21	0.136	0.09	0.09	0.767
• 11–15 years old	0.07	0.08	0.254	0.04	0.03	0.020
• 16–17 years old	0.00	0.00	0.084	0.01	0.01	0.184
<i>Socioeconomic and demographic background</i>						
Mother's educational level						
• Low	0.27	0.28	0.741	0.28	0.28	0.752
• Medium	0.48	0.45	0.091	0.47	0.46	0.498
• High	0.23	0.24	0.725	0.23	0.23	0.770
• Missing data	0.02	0.04	0.003	0.01	0.03	<0.001
Father's educational level						
• Low	0.33	0.32	0.434	0.32	0.32	0.861
• Medium	0.41	0.40	0.635	0.44	0.40	0.025
• High	0.20	0.21	0.408	0.21	0.21	0.934
• Missing data	0.06	0.07	0.294	0.03	0.07	<0.001
Mother's income (annual mean, EUR) ^e	17,416	17,649	0.520	17,844	17,576	0.438
Father's income (annual mean, EUR) ^f	25,348	24,530	0.191	24,503	24,043	0.399
Parent born in a non-Nordic country	0.05	0.09	<0.001	0.04	0.10	<0.001

^aCalculated using the Student's t-test and test of proportions. ^bData in the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) was missing for T1DM n=81, and comparators n=490.

^cLISA data was missing for T1DM n=69, and comparators n=449. ^dGross income. ^eLISA data was missing for T1DM n=34, and comparators n=285. ^fLISA data was missing for T1DM n=101, and comparators n=562.

Table 2: Effect of type 1 diabetes mellitus (T1DM) on employment and earnings among women between the ages of 19 and 32

T1DM effect	Logistic random effect Employment				Linear random effect Ln(earnings) if employed				
	n	Obs.	OR	95% CI	n	Obs.	β	SE	p
Model 1: unadjusted	6,104	83,521	0.841	0.756–0.934	5,850	54,487	-0.055	0.017	0.001
Model 1: unadjusted (reduced sample)	5,725	78,393	0.869	0.781–0.967	5,509	51,536	-0.056	0.017	0.001
Model 2: adjusted for socioeconomic background*	5,725	78,393	0.808	0.713–0.917	5,509	51,536	-0.055	0.016	0.001
Model 3: adjusted for socioeconomic background* + education	5,725	78,393	0.818	0.725–0.924	5,509	51,536	-0.046	0.016	0.004
Model 4: adjusted for socioeconomic background* + children	5,725	78,393	0.805	0.707–0.915	5,509	51,536	-0.059	0.017	<0.001
Model 5: adjusted for socioeconomic background* + age									
- Comparators (ref)	5,725	78,393	-	-	5,509	51,536	-	-	-
- Years since diagnosis									
4–9			0.947	0.796–1.127			0.026	0.031	0.395
10–12			0.838	0.719–0.978			0.040	0.025	0.113
13–15			0.864	0.748–0.998			-0.062	0.025	0.015
16–18			0.788	0.682–0.910			-0.076	0.026	0.003
19–21			0.802	0.691–0.931			-0.107	0.029	<0.001
22–24			0.749	0.640–0.877			-0.081	0.037	0.027
25–32			0.624	0.516–0.755			-0.049	0.047	0.299

*Adjusted for parents' education, and income, if having a parent born in a non-Nordic country and calendar year.
CI = confidence interval; Obs. = number of observations; OR = odds ratio; SE = standard error (robust).

Table 3: Effect of type 1 diabetes mellitus (T1DM) on employment and earnings among men between the ages of 19 and 32

T1DM effect	Logistic random effect Employment				Linear random effect Ln(earnings) if employed				
	n	Obs.	OR	95% CI	n	Obs.	β	SE	p
Model 1: unadjusted	6,058	83,670	1.083	0.976–1.201	5,862	58,588	-0.031	0.014	0.026
Model 1: unadjusted (reduced sample)	5,735	79,296	1.040	0.932–1.160	5,560	55,994	-0.037	0.013	0.005
Model 2: adjusted for socioeconomic background*	5,735	79,296	0.995	0.860–1.150	5,560	55,994	-0.033	0.014	0.015
Model 3: adjusted for socioeconomic background* + education	5,735	79,296	1.008	0.875–1.160	5,560	55,994	-0.029	0.014	0.035
Model 4: adjusted for socioeconomic background* + children	5,735	79,296	0.996	0.863–1.150	5,560	55,994	-0.034	0.014	0.014
Model 5: adjusted for socioeconomic background* + age									
- Comparators (ref)	5,735	79,296	–	–	5,560	55,994	–	–	–
- Years since diagnosis									
4–9			1.306	1.093–1.560			0.085	0.026	0.001
10–12			1.071	0.907–1.265			0.051	0.020	0.012
13–15			1.148	0.978–1.348			-0.008	0.018	0.645
16–18			0.862	0.733–1.014			-0.019	0.017	0.271
19–21			0.860	0.715–1.034			-0.068	0.019	<0.001
22–24			0.715	0.573–0.892			-0.110	0.022	<0.001
25–32			0.535	0.404–0.709			-0.163	0.029	<0.001

*Adjusted for parents' education, and income, if having a parent born in a non-Nordic country and calendar year. CI = confidence interval; Obs. = number of observations; OR = odds ratio; SE = standard error (robust).

Table 4: Effect of type 1 diabetes mellitus (T1DM) on employment and earnings among women between 19–26 and 27–32 years of age

T1DM effect	Logistic random effect Employment				Linear random effect Ln(earnings) if employed				
	n	Obs.	OR	95% CI	n	Obs.	β	SE	p
Women 19–26 years old									
Model 1: unadjusted	6,101	48,163	0.899	0.799–1.012	5,576	26,418	-0.016	0.016	0.307
Model 1: unadjusted (reduced sample)	5,723	45,208	0.929	0.823–1.424	5,252	24,991	-0.015	0.016	0.367
Model 2: adjusted for socioeconomic background*	5,723	45,208	0.888	0.778–1.013	5,252	24,991	-0.015	0.017	0.385
Women 27–32 years old									
Model 1: unadjusted	5,685	35,358	0.564	0.451–0.706	5,539	28,069	-0.091	0.024	<0.001
Model 1: unadjusted (reduced sample)	5,617	33,185	0.595	0.474–0.748	5,227	26,545	-0.098	0.024	<0.001
Model 2: adjusted for socioeconomic background*	5,617	33,185	0.558	0.441–0.706	5,227	26,545	-0.096	0.024	<0.001

*Adjusted for parents' education, and income, if having a parent born in a non-Nordic country and calendar year.
CI = confidence interval; Obs. = number of observations; OR = odds ratio; SE = standard error (robust).

Table 5: Effect of type 1 diabetes mellitus (T1DM) on employment and earnings among men between 19–26 and 27–32 years of age

T1DM effect	Logistic random effect				Linear random effect				p
	Employment				Ln(earnings) if employed				
	n	Obs.	OR	95% CI	n	Obs.	β	SE	
Men 19–26 years old									
Model 1: unadjusted	6,056	48,114	1.186	1.055–1.338	5,586	28,562	0.030	0.014	0.028
Model 1: unadjusted (reduced sample)	5,733	45,583	1.146	1.014–1.295	5,307	27,270	0.027	0.014	0.056
Model 2: adjusted for socioeconomic background*	5,733	45,583	1.116	0.959–1.298	5,307	27,270	0.026	0.016	0.098
Men 27–32 years old									
Model 1: unadjusted	5,999	35,556	0.816	0.656–1.015	5,643	30,026	-0.075	0.017	<0.001
Model 1: unadjusted (reduced sample)	5,685	33,713	0.728	0.582–0.910	5,375	28,724	-0.082	0.017	<0.001
Model 2: adjusted for socioeconomic background*	5,685	33,713	0.653	0.517–0.825	5,375	28,724	-0.088	0.017	<0.001

*Adjusted for parents' education, and income, if having a parent born in a non-Nordic country and calendar year. CI = confidence interval; Obs. = number of observations; OR = odds ratio; SE = standard errors (robust).

Table 6: Effect of type 1 diabetes mellitus (T1DM) on higher education and years of schooling at the age of 32 years for women and men

T1DM effect	OLS			Logistic			
	Years of schooling			OR of university education		OR of ≥ 3 years' university education	
	β	SE	p	OR	95% CI	OR	95% CI
Women							
Model 1: unadjusted (n=5,813)	-0.264	0.070	<0.001	0.806	0.707–0.920	0.802	0.700–0.921
Model 1: unadjusted (reduced sample) (n=5,463)	-0.245	0.072	0.001	0.815	0.712–0.934	0.808	0.702–0.931
Model 2: adjusted* (n=5,463)	-0.249	0.067	<0.001	0.793	0.685–0.917	0.784	0.674–0.912
Men							
Model 1: unadjusted (n=5,873)	-0.178	0.068	0.009	0.843	0.738–0.962	0.833	0.717–0.968
Model 1: unadjusted (reduced sample) (n=5,568)	-0.206	0.069	0.003	0.837	0.732–0.957	0.821	0.705–0.957
Model 2: adjusted* (n=5,568)	-0.219	0.063	0.001	0.804	0.695–0.931	0.793	0.674–0.934

*Adjusted for parents' education and income, if having a parent born in a non-Nordic country. CI = confidence interval; OLS = Ordinary Least Squares; OR = odds ratio. SE = standard error (robust).

Appendix

Table A1: Logistic random effects models of employment between the ages of 19 and 32 years for women with type 1 diabetes mellitus (T1DM)

	Model 2		Model 3		Model 4	
	OR	95% CI	OR	95% CI	OR	95% CI
T1DM	0.81	0.71–0.92	0.82	0.73–0.92	0.81	0.71–0.92
Education						
- Low			0.47	0.40–0.55		
- Medium (reference)						
- High			0.95	0.86–1.04		
- Missing data			0.02	0.00–0.06		
Children					0.61	0.56–0.67
Mother's education						
- Low	1.10	0.97–1.24	1.13	1.01–1.27	1.12	0.99–1.27
- Medium (reference)						
- High	0.64	0.57–0.73	0.66	0.59–0.74	0.63	0.55–0.71
- Missing data	0.34	0.11–1.04	0.41	0.13–1.21	0.33	0.11–1.05
Father's education						
- Low	1.06	0.95–1.19	1.08	0.97–1.21	1.07	0.95–1.20
- Medium (reference)						
- High	0.66	0.57–0.75	0.66	0.59–0.74	0.64	0.57–0.73
- Missing data	0.68	0.38–1.20	0.77	0.45–1.74	0.72	0.40–1.28
Mother's income	5.61	3.49–9.03	4.42	2.80–6.99	4.97	3.06–8.07
Father's income	1.35	1.03–1.78	1.29	0.99–1.69	1.30	0.98–1.71
Non-Nordic parent	0.43	0.35–0.54	0.45	0.36–0.55	0.42	0.33–0.52
Year						
- 1991 (reference year)						
- 1992	0.60	0.47–0.76	0.58	0.46–0.74	0.61	0.48–0.78
- 1993	0.36	0.28–0.46	0.34	0.27–0.44	0.37	0.29–0.48
- 1994	0.44	0.34–0.56	0.41	0.32–0.53	0.46	0.36–0.59
- 1995	0.53	0.41–0.68	0.50	0.39–0.64	0.57	0.45–0.73
- 1996	0.59	0.46–0.76	0.56	0.44–0.71	0.65	0.51–0.83
- 1997	0.68	0.53–0.86	0.64	0.50–0.82	0.76	0.59–0.97
- 1998	1.21	0.94–1.55	1.12	0.87–1.44	1.38	1.08–1.77
- 1999	1.37	1.07–1.76	1.27	0.99–1.63	1.59	1.24–2.04
- 2000	1.86	1.45–2.39	1.69	1.31–2.18	2.20	1.71–2.84
- 2001	2.49	1.93–3.20	2.26	1.75–2.92	3.01	2.33–3.89
- 2002	3.04	2.36–3.91	2.74	2.11–3.55	3.77	2.91–4.87
- 2003	3.47	2.69–4.45	3.11	2.40–4.03	4.42	3.41–5.71
- 2004	4.56	3.53–5.88	4.08	3.14–5.30	5.99	4.61–7.78
- 2005	5.59	4.33–7.21	4.99	3.83–6.49	7.54	5.79–9.81
- 2006	7.81	6.00–10.12	6.94	5.29–9.10	10.82	8.25–14.18
- 2007	10.15	7.75–13.26	9.02	6.83–11.91	14.50	10.96–19.17
- 2008	11.21	8.48–14.76	9.93	7.44–13.24	16.48	12.34–22.02
- 2009	10.13	7.56–13.52	8.92	6.60–12.06	15.33	11.31–20.79
- 2010	14.11	10.07–19.67	12.41	8.78–17.52	21.90	15.45–31.06
Constant	1.10	0.87–1.40	1.41	1.09–1.84	1.14	0.88–1.49
Number of observations		78,393		78,393		78,393
Number of individuals		5,725		5,725		5,725
Average number of observations per individual		13.7		13.7		13.7

CI = confidence interval; OR = odds ratio.

Table A2: Logistic random effects models of employment between the ages of 19 and 32 years for men with type 1 diabetes mellitus (T1DM)

	Model 2		Model 3		Model 4	
	OR	95% CI	OR	95% CI	OR	95% CI
T1DM	1.00	0.86–1.15	1.01	0.88–1.16	1.00	0.86–1.15
Education						
- Low			0.49	0.41–0.59		
- Medium (reference)						
- High			0.67	0.60–0.74		
- Missing data			0.05	0.02–0.17		
Children					1.71	1.50–1.95
Mother's education						
- Low	1.26	1.09–1.45	1.28	1.10–1.46	1.25	1.09–1.45
- Medium (reference)						
- High	0.55	0.47–0.64	0.57	0.50–0.66	0.55	0.48–0.64
- Missing data	0.45	0.15–1.36	0.46	0.16–1.27	0.44	0.15–1.29
Father's education						
- Low	1.34	1.17–1.54	1.36	1.19–1.56	1.34	1.17–1.54
- Medium (reference)						
- High	0.60	0.52–0.70	0.64	0.55–0.74	0.61	0.53–0.71
- Missing data	0.71	0.31–1.56	0.77	0.37–1.62	0.72	0.33–1.58
Mother's income	4.92	2.71–8.96	4.08	2.28–7.30	5.35	2.96–9.67
Father's income	1.34	0.96–1.86	1.30	0.94–1.80	1.36	0.98–1.89
Non-Nordic parent	0.05	0.30–0.48	0.40	0.32–0.51	0.38	0.30–0.48
Year						
- 1991 (reference year)						
- 1992	0.41	0.32–0.54	0.42	0.33–0.54	0.41	0.32–0.53
- 1993	0.28	0.22–0.37	0.29	0.22–0.38	0.28	0.22–0.36
- 1994	0.64	0.50–0.83	0.66	0.51–0.85	0.63	0.48–0.81
- 1995	1.12	0.87–1.45	1.16	0.89–1.50	1.08	0.84–1.39
- 1996	1.24	0.96–1.60	1.29	0.99–1.67	1.18	0.91–1.53
- 1997	1.78	1.38–2.30	1.87	1.44–2.42	1.68	1.30–2.17
- 1998	3.46	2.67–4.49	3.64	2.80–4.74	3.25	2.51–4.20
- 1999	5.09	3.92–6.61	5.43	4.16–7.09	4.73	3.64–6.14
- 2000	8.39	6.44–10.94	9.05	6.89–11.87	7.71	5.92–10.05
- 2001	10.54	8.07–13.76	11.48	8.73–15.09	9.57	7.33–12.49
- 2002	11.75	8.99–15.35	12.87	9.77–16.96	10.51	8.04–13.74
- 2003	12.42	9.51–16.23	13.70	10.39–18.06	10.93	8.36–14.30
- 2004	16.04	12.21–21.06	17.76	13.39–23.57	13.84	10.52–18.20
- 2005	21.35	16.22–28.12	23.83	17.90–31.72	18.03	13.67–23.79
- 2006	31.36	23.62–41.63	35.19	26.19–47.27	26.00	19.53–34.61
- 2007	47.35	35.37–63.38	53.48	39.44–72.52	38.76	28.87–52.04
- 2008	55.71	41.09–75.52	62.88	45.79–86.34	44.68	32.82–60.83
- 2009	40.30	29.37–55.30	45.72	32.84–63.64	31.25	22.66–43.10
- 2010	60.35	41.95–86.84	68.69	47.05–100.3	46.63	32.22–67.50
Constant	0.59	0.44–0.79	0.68	0.51–0.91	0.59	0.44–0.78
Number of observations		79,296		79,296		79,296
Number of individuals		5,735		5,735		5,735
Average number of observations per individual		13.8		13.8		13.8

CI = confidence interval; OR = odds ratio.

Table A3: Random effects models of earnings between the ages of 19 and 32 years for women with type 1 diabetes mellitus (T1DM)

	Model 2			Model 3			Model 4		
	β	SE	p	β	SE	p	β	SE	p
T1DM	-0.06	0.02	0.001	-0.05	0.02	0.004	-0.06	0.02	<0.001
- Education				-0.15	0.03	<0.001			
- Low									
- Medium (reference)				0.26	0.01	<0.001			
- High				-0.04	0.10	0.705			
Missing data							-0.79	0.01	<0.001
Children									
- Mother's education	0.00	0.01	0.757	0.03	0.01	0.067	0.04	0.01	0.010
- Low									
- Medium (reference)	-0.03	0.02	0.108	-0.07	0.02	<0.001	-0.06	0.02	<0.001
- High	0.03	0.14	0.808	0.04	0.13	0.746	-0.02	0.12	0.841
Missing data									
- Father's education	-0.02	0.04	0.136	-0.01	0.01	0.742	-0.01	0.01	0.493
- Low									
- Medium (reference)	-0.01	0.02	0.553	-0.04	0.02	0.023	-0.05	0.02	0.002
- High	-0.06	0.09	0.510	-0.03	0.08	0.741	0.02	0.09	0.827
Missing data	0.54	0.07	<0.001	0.44	0.07	<0.001	0.33	0.07	<0.001
Mother's income	0.14	0.04	<0.001	0.10	0.04	0.013	0.07	0.04	0.098
Father's income	-0.01	0.03	0.733	-0.00	0.03	0.905	-0.06	0.03	0.051
Non-Nordic parent									
- Year									
- 1991 (reference year)	0.05	0.04	0.179	0.04	0.04	0.305	0.10	0.04	0.012
- 1992	0.05	0.04	0.231	0.02	0.04	0.509	0.11	0.04	0.003
- 1993	0.06	0.04	0.124	0.03	0.04	0.490	0.15	0.04	<0.001
- 1994	0.17	0.04	<0.001	0.13	0.04	<0.001	0.29	0.03	<0.001
- 1995	0.27	0.04	<0.001	0.22	0.04	<0.001	0.41	0.03	<0.001
- 1996	0.34	0.04	<0.001	0.28	0.04	<0.001	0.52	0.04	<0.001
- 1997	0.47	0.04	<0.001	0.40	0.04	<0.001	0.68	0.04	<0.001
- 1998	0.63	0.04	<0.001	0.54	0.04	<0.001	0.86	0.04	<0.001
- 1999	0.70	0.04	<0.001	0.59	0.04	<0.001	0.96	0.04	<0.001
- 2000	0.72	0.04	<0.001	0.61	0.04	<0.001	1.03	0.04	<0.001
- 2001	0.73	0.04	<0.001	0.61	0.04	<0.001	1.08	0.04	<0.001
- 2002	0.74	0.04	<0.001	0.61	0.04	<0.001	1.14	0.04	<0.001
- 2003	0.71	0.04	<0.001	0.58	0.04	<0.001	1.17	0.04	<0.001
- 2004	0.75	0.04	<0.001	0.62	0.04	<0.001	1.26	0.04	<0.001
- 2005	0.78	0.04	<0.001	0.64	0.04	<0.001	1.33	0.04	<0.001
- 2006	0.84	0.04	<0.001	0.70	0.04	<0.001	1.44	0.04	<0.001
- 2007	0.89	0.04	<0.001	0.74	0.04	<0.001	1.54	0.04	<0.001
- 2008	0.95	0.04	<0.001	0.79	0.04	<0.001	1.64	0.04	<0.001
- 2009	0.96	0.05	<0.001	0.80	0.05	<0.001	1.68	0.05	<0.001
- 2010	11.01	0.04	<0.001	11.07	0.04	<0.001	11.00	0.04	<0.001
Constant			51,536			51,536			51,536
Number of observations			5,509			5,509			5,509
Number of individuals			9.4			9.4			9.4
Average number of observations per individual			0.0793			0.0872			0.2077
R-squared: within			0.0793			0.0872			0.2077
between			0.0908			0.1326			0.1585
overall			0.0733			0.0849			0.1651

SE = standard error (robust).

Table A4: Random effects models of earnings between the ages of 19 and 32 years for men with type 1 diabetes mellitus (T1DM)

	Model 2			Model 3			Model 4		
	β	SE	p	β	SE	p	β	SE	p
T1DM	-0.03	0.01	0.015	-0.03	0.01	0.035	-0.03	0.01	0.014
Education									
- Low				-0.11	0.02	<0.001			
- Medium (reference)									
- High				0.13	0.02	<0.001			
- Missing data				-0.23	0.11	0.039			
Children							-0.08	0.01	<0.001
Mother's education									
- Low	0.03	0.01	0.039	0.04	0.01	0.004	0.03	0.01	0.038
- Medium (reference)									
- High	-0.06	0.02	<0.001	-0.08	0.02	<0.001	-0.06	0.02	<0.001
- Missing data	-0.08	0.09	0.391	-0.08	0.09	0.403	-0.08	0.09	0.419
Father's education									
- Low	0.01	0.01	0.320	0.02	0.01	0.071	0.01	0.01	0.315
- Medium (reference)									
- High	-0.05	0.02	0.002	-0.07	0.02	<0.001	-0.05	0.02	0.001
- Missing data	0.02	0.08	0.755	0.03	0.07	0.607	0.02	0.07	0.819
Mother's income	0.29	0.06	<0.001	0.23	0.06	<0.001	0.27	0.06	<0.001
Father's income	0.16	0.04	<0.001	0.01	0.04	0.001	0.15	0.04	<0.001
Non-Nordic parent	-0.16	0.03	<0.001	-0.16	0.03	<0.001	-0.16	0.03	<0.001
Year									
- 1991 (reference year)									
- 1992	0.06	0.05	0.218	0.05	0.05	0.252	0.06	0.05	0.203
- 1993	0.11	0.04	0.013	0.10	0.04	0.029	0.11	0.04	0.010
- 1994	0.15	0.04	<0.001	0.13	0.04	0.001	0.15	0.04	<0.001
- 1995	0.38	0.04	<0.001	0.36	0.04	<0.001	0.39	0.04	<0.001
- 1996	0.51	0.04	<0.001	0.49	0.04	<0.001	0.52	0.04	<0.001
- 1997	0.62	0.04	<0.001	0.60	0.04	<0.001	0.63	0.04	<0.001
- 1998	0.80	0.04	<0.001	0.78	0.04	<0.001	0.82	0.04	<0.001
- 1999	0.97	0.04	<0.001	0.93	0.04	<0.001	0.98	0.04	<0.001
- 2000	1.08	0.04	<0.001	1.04	0.04	<0.001	1.10	0.04	<0.001
- 2001	1.16	0.04	<0.001	1.12	0.04	<0.001	1.19	0.04	<0.001
- 2002	1.20	0.04	<0.001	1.15	0.04	<0.001	1.22	0.04	<0.001
- 2003	1.23	0.04	<0.001	1.19	0.04	<0.001	1.26	0.04	<0.001
- 2004	1.26	0.04	<0.001	1.21	0.04	<0.001	1.29	0.04	<0.001
- 2005	1.35	0.04	<0.001	1.30	0.04	<0.001	1.38	0.04	<0.001
- 2006	1.41	0.04	<0.001	1.36	0.04	<0.001	1.45	0.04	<0.001
- 2007	1.48	0.04	<0.001	1.42	0.04	<0.001	1.52	0.04	<0.001
- 2008	1.56	0.04	<0.001	1.51	0.04	<0.001	1.61	0.04	<0.001
- 2009	1.60	0.04	<0.001	1.54	0.04	<0.001	1.65	0.04	<0.001
- 2010	1.62	0.04	<0.001	1.56	0.04	<0.001	1.67	0.05	<0.001
Constant	11.00	0.04	<0.001	11.05	0.04	<0.001	11.00	0.04	<0.001
Number of observations			55,994			55,994			55,994
Number of individuals			5,560			5,560			5,560
Average number of observations per individual			10.1			10.1			10.1
R-squared: within			0.3655			0.3690			0.3682
between			0.0724			0.0853			0.0689
overall			0.2407			0.2435			0.2384

SE = standard error (robust).

Table A5: Odds ratio (OR) of individuals with type 1 diabetes mellitus (T1DM) having a university degree at the age of 32 years: Model 2

	Women		Men	
	Years of education β p	OR of university degree (95% CI)	Years of education β p	OR of university degree (95% CI)
T1DM	-0.25, <0.001	0.79 (0.69–0.92)	-0.22, 0.001	0.80 (0.70–0.93)
Mother's education				
- Low	-0.37, <0.001	0.70 (0.61–0.80)	-0.37, <0.001	0.69(0.59–0.80)
- Medium (reference)				
- High	0.71, <0.001	2.21 (1.88–2.59)	0.74, <0.001	2.08(1.77–2.43)
- Missing data	-0.25, 0.692	1.17 (0.43–3.18)	-0.58, 0.186	0.82 (0.32–2.09)
Father's education				
- Low	-0.26, <0.001	0.77 (0.68–0.88)	-0.33, <0.001	0.66 (0.57–0.76)
- Medium (reference)				
- High	0.60, <0.001	1.75 (1.48–2.07)	0.68, <0.001	2.08 (1.77–2.44)
- Missing data	-0.31, 0.401	1.02 (0.50–2.06)	-0.24, 0.521	0.85 (0.43–1.66)
Mother's income	2.00, <0.001	5.68 (3.03–10.65)	1.52, <0.001	3.69 (1.97–6.92)
Father's income	1.15, <0.001	3.50 (2.35–5.22)	1.44, <0.001	3.93 (2.61–5.93)
Non-Nordic parent	-0.02, 0.889	1.05 (0.80–1.37)	-0.04, 0.746	1.17 (0.90–1.53)
Constant	12.48, <0.001	0.54 (0.46–0.63)	11.96, <0.001	0.31 (0.26–0.37)
R-squared/Pseudo R-squared	0.1554	0.0991	0.1669	0.1178
Number of individuals	5,463	5,463	5,568	5,568

CI = confidence interval.