The long arm of the family: are parental and grandparental earnings related to young men’s body mass index and cognitive ability?

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Background The lasting impact of parents’ socioeconomic status on their children’s social trajectories and health is well-established, but do such intergenerationally transmitted inequalities persist also into the third generation? This study investigates the importance of parental and grandparental earnings for young men’s body mass index (BMI) and cognitive ability at military conscription.

Methods The database used was UBCoS Multigen, which combines existing data on an Uppsala cohort born 1915–29 with information on several subsequent generations. We analysed young men in the third generation with complete information about the earnings of paternal (n=3577) and maternal (n=4142) ancestors of the two preceding generations using OLS-regression.

Results On the paternal side, father’s and grandfather’s, but not grandmother’s, earnings predicted cognitive ability and BMI. In the mutually adjusted models, the associations with cognitive ability largely remained for young men whose fathers \(b=-0.96\) (95% CI: \(-1.25, -0.66\)) and grandfathers \(b=-0.60\) \((-0.87, -0.33)\) were poor rather than well-off, whereas for BMI, only the association with grandfather’s earnings \(b=0.78\) (0.37, 1.19) persisted. On the maternal side, the mutually adjusted models indicated that the mother’s \(b=-0.89\) \((-1.14, -0.65)\) and the grandfather’s \(b=-0.65\) \((-0.89, -0.41)\), but not the grandmother’s, earnings were predictive of cognitive ability, whereas only the grandfather’s \(b=0.56\) (0.18, 0.94) earnings seemed to be important for BMI.

Conclusions The results suggest that the long arm of the family reaches beyond the second generation in its effect on health. Although this study has only scratched the surface of how health inequalities is reproduced, it suggests that policies that reduce social inequalities may have ramifications across several generations.

Keywords Keywords Intergenerational, health inequalities, parental and grandparental income, BMI, cognitive ability

Introduction The lasting impact of parents’ socioeconomic position on their children’s social trajectories1–3 and health4–6 is well-established. In line with this, parental socioeconomic status has also been found to be important for the developmental health of the next generation,
as indicated by studies of cognitive ability7,8 and body mass index (BMI).9,10 Such indicators, in turn, are predictive of social mobility11,12 as well as future health13–15 and cardiovascular7,16–18 and all-cause19–21 mortality, although for BMI this is not a universal finding.22 Even though socioeconomic position can be assessed in different ways, low income has been shown to be adversely associated with both cognitive ability,23,24 and BMI.25,26

Economic mobility across families can be assessed through intergenerational income correlations23,27 A study of Swedish men born in the mid-20th century showed that 25% of those who had relatively poor fathers were relatively poor themselves.28 Hence, to understand how contemporary health disadvantages among young people today originated, it seems pertinent not only to include the economic circumstances of their parents in the analyses but also those of their grandparents. Few health-related studies have been able to take more than two family generations into consideration, but the importance of grandparental social characteristics for children’s cognitive development and health has nevertheless been demonstrated in a handful of investigations.29–33

The overall aim of our study is to investigate whether the long arm of the family reaches beyond the parent–child relation, so that also the income situation of grandparents matter for these two central indicators of young men’s developmental health status.34

While there is ample evidence about the existence of a strong relation between parent’s economic situation and numerous health and social outcomes, less is known about the operating mechanisms. Regarding cognitive ability, early-life and prolonged exposure to poverty have been found to be particularly detrimental.30,35,36 The literature points to a multitude of ways in which the parents’ financial situation affects children’s cognitive ability.35,37 These include the more direct effects of poverty, such as poor diet, poor housing conditions, poor neighbourhood environment and inferior access to goods and activities that may stimulate cognitive development. They also include parental psychological stress stemming from economic problems.38 Such parental stress is often accompanied by parenting styles that do not favour the intellectual development of the child.39–41

Moreover, confounding factors such as the parents’ own cognitive ability,42 education43 and psychological health44 are of course also part of the explanation. While most studies carried out in this area of research tend to find that income has an independent effect even when potential mediators have been adjusted for,35,37,44 others have managed to fully ‘explain’ the direct effect of family income.24 Nevertheless, it is important to bear in mind that the identification of pathways through which parental income affects children’s intellectual development is not to prove income unimportant. Parental income is closely tied to, or even decisive for, many of the mediators that have previously been found to be most influential.24,43

The literature covering the potential pathways through which parental income operates to cause an increased prevalence of overweight and obese children in poor families45 and neighbourhoods,26 on the other hand, is limited and largely concerned with eating behaviours.46 While bearing in mind that ancestral income perhaps largely reflects indirect effects on the studied outcomes, this study examines the implications of parents’ and grandparents’ income for young men’s BMI and cognitive ability at the time of military conscription without taking potential mediators into consideration.

**Methods**

The material used stems from the Uppsala Birth Cohort Multigeneration database (UBCoS Multigen) consisting of 12 168 men and women born at Uppsala University Hospital in 1915–29 (the Uppsala Birth Cohort Study), their children (n = 21 070) and grandchildren (n = 37 234).47,48 For each child that a parent ‘contributed’ to the ensuing generation, the second parent of that child was traced as well. This means that practically full information on both mothers and fathers are available for the second and third generation, and that almost full lineage information about paternal or maternal grandparents exists for the third generation. Information from several registers such as national censuses and the Conscript Registry has been linked to the data. The database thereby allows the study of intergenerational associations forward in time rather than retrospectively, starting at the beginning of the last century.

The present study focuses on the third generation at the time of military conscription, but takes information about their parents and grandparents into consideration as well. The numbers and birth year distributions of all males in the third generation (born up to 2002) and their biological ancestors are presented in Figure 1. Although practically all have both of their parents identified, information about their grandparents is, with a few exceptions, available for either the maternal or the paternal side. The statistical analyses were, therefore, carried out separately for study subjects descending from paternal vs maternal ancestors.

Figure 2 shows the process by which the final number of study subjects was selected. Although full paternal and/or maternal lineage information is available for about 18 754 males in the third generation, only around 60% of them were old enough to have gone through military conscription by 2004, which is the end-point for which data is available. Complete variable information on the paternal and the maternal side is available for 4040 and 4789 young men, respectively. However, to make the...
multigenerational analyses possible, some ‘age trimming’ of the earlier generations was deemed necessary, which further reduced the numbers somewhat.

How this ‘age trimming’ was performed is shown in Figure 3. Since suitable census information on earnings was available only for 1970 and 1990, the age-span for parents and grandparents at the time of income assessment would otherwise have become unreasonably wide. By ‘cutting off’ the tails of the birth year distributions (compare thin vs thick dots in Figure 3), the age intervals were compressed to 40–64 (1970) for grandparents and 30–54 (1990) for parents. By such age restriction we also get income information at an age when annual earning is a good proxy for life-time income.49 BMI and cognitive ability at military conscription were assessed in 1980–2002 (mean age = 18.2). Thus, for young men who completed their military conscription in the 1980s (≈30%), parental income was assessed at a later point in time than were the two outcomes under study here. In these cases, parental income in 1990 serves as a proxy of the corresponding earnings some 5–10 years prior to that. Additional analyses restricted to those who completed their conscription in the 1990s (≈70%) yielded practically identical findings to the analyses which also included the 1980s conscripts (data not shown). Figure 4a and b show the numbers and the birth year distributions of the selected study subjects together with that of their paternal or maternal ancestors.

Table 1 gives descriptive statistics for the included variables. BMI was calculated using body weight in kilos divided by height in square meters. General ability was assessed by means of an ability test (designed to capture spatial, verbal, logical and technical ability). Both these outcome variables are measured in late adolescence. Region of enlistment consists of the six conscript offices in Sweden during the period under study. The offices were collapsed into four regions. Due to potential regional differences in the practice of measuring and assessing the conscripts this variable is adjusted for in all analyses. The income variables—parents’ earnings and grandparents’ earnings—were retrieved from census data. Our earnings data include income that is taxable, which could also be termed work-related income.
Research Questions

We investigate the direct effects of parental and grandparental earnings on young men’s cognitive ability as well as their BMI at the time of military conscription. Almost complete information on income is available for the entire paternal lineage (father, paternal grandmother and grandfather) or the entire maternal lineage (mother, maternal grandmother and grandfather) of our study subjects. The basic question posed is whether the long arm of the family reaches beyond the parent–child relationship, so that the socioeconomic characteristics of our grandparents also matter. More specifically, we will examine (i) the intergenerational income correlation between the men constituting generation 1 and 2 in the present study, (ii) the direct and mutually adjusted relevance of paternal and paternal grandparents’ earnings for the BMI and cognitive ability of young men in the third generation and (iii) the direct and mutually adjusted relevance of maternal and maternal grandparents’ earnings for BMI and cognitive ability of young men in the third generation.

Results

Before analysing the possible impact of parents’ and grandparents’ earnings on young men’s BMI and cognitive ability it is of interest to look at the association between our earnings measures as such. Table 2 gives the probability of fathers’ income class conditional on the income class of grandfathers. Thus, the first row shows the likelihood of fathers (i.e., sons of the grandfathers) belonging to the various income classes in cases where the grandfather was poor according to our definition. Similarly, the last row shows the corresponding probabilities of those who
had a grandfather with a high income. As seen, a relatively strong intergenerational association exists. If the grandfather’s earnings belong to the highest (well-to-do) income class, the father is 3–4 times more likely also to be found in the highest income class than if the grandfather’s earnings had been in the poorest category (0.296/0.081). The associations seen in this mobility matrix are, by and large, similar.
to those found by Björklund and Jäntti28 using another Swedish data material covering roughly the same age cohorts.

Figure 5a illustrates the direct and mutually adjusted effects of paternal ancestors’ earnings on their male offspring’s BMI. The paternal grandfather’s earnings seem to exert the strongest influence on these young men’s BMI, with a clearly increasing trend as the income of the grandfather decreases. The income of the paternal grandmother, on the other hand, appears to be irrelevant. As for the relevance of the father’s earnings, a weak association in the ‘crude’ model attenuates to an insignificant level once the paternal grandparents’ earnings are taken into consideration. In the mutually adjusted model, young men whose paternal grandfathers were classified as poor in 1970 demonstrate an average of 0.78 BMI-units above those of young men whose paternal grandfathers were well-off that same year.

Table 1 Variables included in the analyses

<table>
<thead>
<tr>
<th>Outcomes in generation 3</th>
<th>Paternal lineage</th>
<th>Maternal lineage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>n = 3577</td>
<td>n = 4142</td>
</tr>
<tr>
<td>Range (mean)</td>
<td>15.1–43.4 (22.1)</td>
<td>14.7–38.3 (22.0)</td>
</tr>
<tr>
<td>Cognitive ability</td>
<td>Range (mean)</td>
<td>1–9 (5.2)</td>
</tr>
</tbody>
</table>

**Independent variables:**

<table>
<thead>
<tr>
<th>Region of enlistment (%)</th>
<th>Kristianstad or Göteborg</th>
<th>Stockholm</th>
<th>Karlstad</th>
<th>Östersund or Boden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>404 (11.3)</td>
<td>2453 (68.6)</td>
<td>483 (13.5)</td>
<td>237 (6.6)</td>
</tr>
<tr>
<td>Parent’s income 1990 (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>306 (8.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower middle</td>
<td>1485 (41.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher middle</td>
<td>1299 (36.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well to do</td>
<td>487 (13.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grandfather’s income 1970 (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>425 (11.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower middle</td>
<td>1366 (38.2)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Higher middle</td>
<td>1094 (30.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well to do</td>
<td>692 (19.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grandmother’s income 1970 (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>1399 (39.1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower middle</td>
<td>383 (10.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher middle</td>
<td>513 (14.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well to do</td>
<td>1282 (35.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Fathers’ income class conditional on grandparents’ income in Swedish currency (SEK), according to the 1990 value

<table>
<thead>
<tr>
<th>Grandfathers’ income class</th>
<th>Fathers’ income class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor ≤78 997</td>
</tr>
<tr>
<td>Poor</td>
<td>0.125</td>
</tr>
<tr>
<td>78 998–157 994</td>
<td>0.090</td>
</tr>
<tr>
<td>Higher middle</td>
<td>0.088</td>
</tr>
<tr>
<td>Well-to-do</td>
<td>≥236 993</td>
</tr>
</tbody>
</table>

For each category of income among grandfathers, the numbers given in the table are the probability of belonging to any of the four income classes for the male ancestor.

Source: UBCoS Multigen data.
The corresponding estimates according to maternal ancestor’s earnings are shown in Figure 5b. The only ancestor whose earnings seem to be of importance for young men’s BMI is the maternal grandfather. Here too, a graded pattern can be noted, with decreasing BMI-scores as the income of the grandfather increases. Young men whose maternal grandfathers were poor in 1970 demonstrate an average of 0.56 BMI-units above their male peers whose maternal grandfathers were classified as well-to-do that year. Thus, when it comes to young men’s BMI, it appears as if grandfathers’, but not grandmothers’ or even parents’ income is of importance for the outcome.

Nevertheless, it should be pointed out here that the explained variance in grandsons’ BMI according to ancestral income is rather low (around 2% in the adjusted models). Thus, for a young man of average height in the data (180 cm), the ‘crude’ estimate for BMI among those of poor paternal grandfathers ($b = 0.86$) corresponds to a 2.8k higher body weight vis-à-vis those of grandfathers who were well-to-do. This estimate is equivalent to roughly one-third of a standard deviation in magnitude.

Where cognitive ability is concerned (Figure 6a and b), results are more as one might expect. Here, the income of the parents is more strongly correlated with young men’s cognitive abilities. The cognitive abilities of young men whose parental income was lower middle have a lower mean than those whose parental income was well-to-do.

Figure 5 (a) Effect of paternal ancestors’ income on young men’s BMI at the time of conscription ($\approx 18$ years). All estimates are adjusted for region of enlistment as well as (grand)sons’ and their ancestors’ birth years. (b) Effect of maternal ancestors’ income on young men’s BMI at the time of conscription ($\approx 18$ years). All estimates are adjusted for region of enlistment as well as (grand)sons’ and their ancestors’ birth years.
with their sons’ cognitive ability than that of the grandfathers. In the mutually adjusted model, young men whose fathers were poor in 1990 have an average score of almost one unit below that of men whose fathers were well-off that year. The corresponding figure for young men whose mothers were poor in 1990 is -0.89. The grandfathers’ earnings also seem to be of importance for these men’s cognition, the estimates for cognitive ability being -0.60 and -0.65, respectively, for grandsons whose paternal and maternal grandfathers were poor rather than well-off in 1970. Here too, more or less graded relationships are found throughout the analyses of parents and grandfathers. As for grandmothers’ earnings, there seem to be no relationship between these and young men’s cognitive ability. Hence, mother’s and father’s earnings as well as those of maternal and paternal grandfathers seem to be of substantial importance. The explained variance is also considerably higher than that found for BMI, corresponding to ~8% in the adjusted models. The estimates for poor vs well-to-do fathers are, for example, equivalent to roughly

Figure 6 (a) Effect of paternal ancestors’ income on young men’s cognitive ability at conscription. All estimates are adjusted for region of enlistment as well as (grand)sons’ and their ancestors’ birth years. (b) Effect of maternal ancestors’ income on young men’s cognitive ability at conscription. All estimates are adjusted for region of enlistment as well as (grand)sons’ and their ancestors’ birth years.
Appendix G: The long arm of the family

three fifth of a standard deviation in the distribution of these young men's cognitive ability.

Discussion

The overall aim of this study was to investigate whether grandparental income matters for BMI and cognitive ability among Swedish conscripts born in 1960–85, besides the effect of parental income. These developmental health indicators were assessed at quite a late stage of early life (∼18 years). Other studies have indicated that the influence of socio-economic origin is greater at this age than earlier in life especially for cognitive ability, thereby suggesting that the family impact that we are studying may play a strong role. And indeed, ours results suggest that young Swedish men today whose paternal and maternal grandfathers were relatively poor in 1970 tend have a higher BMI and, especially, a lower cognitive ability in late adolescence than those whose grandfathers were better off that year. Although these estimates are attenuated somewhat in the mutually adjusted models, controlling for parental and grandmaternal earnings, we tend to find an impact that reaches across more than two generations. In other words, our results indicate that not only do the economic circumstances of ones parents matter, but also those of ones grandfathers. Yet, the social gradient according to various risk markers tend to change over time. It is unlikely that we would have found a similar gradient in BMI according to G0's income had we been able to study the grandfathers (G1) when they were young, although in 1970 at ages 40–64, obesity was probably more common also among the low-earning grandparents in the present study.

It may, to some, be surprising that we find evidence for this transmission of health inequalities in Sweden, a country so well-known for its high egalitarian ambitions and achievements. Obviously, then, these pathways are difficult to break. Moreover, we should remember that grandparents' income in our study was measured at a time (1970) when Sweden was probably not that different from many other European countries in terms of the income distribution, because income inequality in Sweden strongly decreased thereafter until the early 1980s.

Whether the higher BMI and the lower cognitive ability of those with lower-earning ancestors place these young men in an 'unhealthy' category of some kind is difficult say. We performed some sensitivity analyses in which we focused on those at the extreme ends of the distribution of BMI and cognitive ability. The share of young men who were obese (BMI ≥ 30) was, in the case of paternal grandfathers' earnings, much higher in the poor (3.1%) than in the well-to-do category (1.2%). Similarly, young men who ended up in the two lowest IQ-categories (8.3%) were considerably more prevalent among those whose paternal grandfather was poor (11.1%) than well-to-do (5.6%). The corresponding proportions in relation to paternal earnings were 14.0% and 2.5%. Thus, a clear over-representation of (grand)sons whose ancestors were poor exists also at the more extreme ends of the BMI and cognitive ability distributions, something which could be assumed to add to these young men's overall risk. Furthermore, obesity is more likely to co-exist with being in the two bottom-categories of cognitive ability among the studied subjects (OR = 2.28, 95% CI: 1.48, 3.49). These associations should not be taken as indicative of an overall deterministic explanatory model implying that they cannot be influenced by social circumstances. Rather, we believe that much of our results indicate the possible influence of social surroundings.

For example we find non-existent impact of grandmother's earnings, which stands in stark contrast to the impact of grandfather's earnings. The fact that grandmothers' earnings in our analyses seem to be irrelevant is, we believe, not a general finding but rather contextually explained. These earnings were measured at a time (1970), and for birth cohorts (1906–30) in which the male breadwinner family was still the norm in Sweden. This explanation is supported when we focus on the separate impact of mother's and father's earnings on young men's cognitive ability. Measured in 1990, the impact of mothers' earnings is on a par with those of fathers. We therefore believe that future studies in which grandmothers' own income is measured at a time when the two-earner family has become the norm will reveal similar findings to what we now find when comparing mothers and fathers.

Hence, while we have refrained from putting our results in an overall explanatory model, we do believe that many social factors could be of relevance for our findings. A more economic perspective would stress the importance of intergenerational financial transfers behind our findings. Although the citizens of a welfare state like Sweden (where education and health care is free or largely subsidised) may be less dependent on such transfers, empirical findings suggest that existing intergenerational financial transfers in Sweden go from older to younger generations, and that this is more common in the higher social strata.

Finally, our study design was deliberately simple. We have focused on the possible impact of economic conditions along a pathway reaching over more than two generations. We have not tried to identify mechanisms and mediators behind this long and winding road, neither do we claim that the associations presented here are altogether casual. In a newly published overview of studies on intergenerational income mobility, for example, the authors estimate the true causal effect to account for about half the initial correlation. Moreover, a recent review and empirical study of family income and child well-being reveal that these relations operate through many different channels. This also suggests that breaking, or at least...
reducing, the intergenerational transmission of health inequalities requires a multi-dimensional approach, which addresses the social distribution of resources more generally. The findings of the present study will hopefully generate hypotheses about mechanisms and pathways that need to be further explored to give a clearer picture of how these kinds of associations can be understood.

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**Conflict of interest:** None declared.

**REFERENCES**


**KEY MESSAGES**

- This study provides evidence that the income of the grandparents matters besides those of the parents for BMI and cognitive ability among Swedish conscripts in 1980–2004.

- The maternal and paternal grandfathers’ earnings were associated with both BMI and cognitive ability in the third generation of young men also when the respective earnings of mothers and fathers were adjusted for. The earnings of the grandmothers, on the other hand, do not appear to play any role for the studied outcomes, a finding most likely because that earnings of grandmothers were measured in the housewife era.

- Mothers’ and fathers’ earnings were associated with cognitive ability, but not with BMI, when the respective earnings of maternal and paternal grandparents were adjusted for. Moreover, parental earnings were more strongly associated with cognitive ability than were grandparental earnings.

- There was a relatively strong intergenerational income correlation between the grandfathers and the fathers of the studied males in third generation, the fathers being 3–4 times more likely to be found in the highest income class in 1990 if the grandfather belonged to the highest, rather than the lowest, income category in 1970.


Modin and Fritzell exploit an amazing Swedish data set that links grandparent and parent earnings to the cognitive test scores and body mass index (BMI) of young men who were conscripted to the military at \(\sim 18\) years of age.\(^1\) Their main finding is that even after controlling for a parent’s earnings, grandfather’s earnings are predictive of the young men’s outcomes. In fact, for BMI, grandfather’s earnings are found to be more important than parent’s earnings, which is quite remarkable. Moreover, grandfather’s earnings are especially important in families in which the grandfather was poor. Grandmother’s earnings are not generally very significant, but as the authors point out, this is unsurprising given that in the grand-mother’s generation, many women did not work.

These findings raise the question of what mechanisms could underlie these findings? The authors discuss the pathways linking parent’s socio-economic status to children’s outcomes, but do not offer any reasons why grandparent’s earnings should have effects on the grandchild other than through effects on the parent’s earnings.

The simplest potential answer is that a parent’s earnings at a point in time are not a sufficient statistic for the parent’s socio-economic status, or even for their permanent income. This may be especially true because the earnings are broken into categories (which entail some loss of information). One adjustment the authors make is to control for the parent’s age and the grandparent’s age at the time income was measured. This adjustment accounts for predictable changes in life-cycle earnings profiles, but, as they acknowledge, it still leaves them short of a comprehensive measure of parent’s socio-economic status or even of permanent income.

This ‘measurement error’ explanation suggests that grandparent earnings remain significant predictors even when parental earnings are controlled simply because parental earnings at a point in time do not capture all of the relevant information about the parent’s socio-economic status. In this interpretation, grandparent’s circumstances do not have an especially long arm: if we can alter the parent’s circumstances, then we ought to be able to improve the child’s.

However, measurement error is unlikely to be the whole story, since it does not explain why a grandfather’s earnings should have a larger effect than a parent’s earnings in the models of BMI. And it is not clear why measurement error should be greater for

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