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Be rich, grow tall? Testing whether parental social origin is associated with filial body height using two German student cohorts

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ABSTRACT

Various theoretical arguments suggest that parental social origin is positively associated with the body height of their children. Using two cohorts from the German National Educational Panel Study (NEPS), which provide prospective panel data covering ages eight to 19, we empirically test this relationship. To capture social origin comprehensively, we operationalize it as a multidimensional construct incorporating economic, educational, and occupational characteristics of both parents. In cross-sectional models with repeated observations of the same individuals, we find that boys from socially advantaged families are, on average, taller. For girls, no association between social origin and height is observed in these models. To examine whether children from socially advantaged families grow faster than their peers, we estimate panel regression models with individual fixed effects. These models indicate that socially advantaged students experience significantly faster growth, a finding that holds for both boys and girls. Finally, using data from the final measurement wave of the secondary school cohort, when respondents are approximately 19 years old, we show that adult height remains associated with parental social origin. Among boys, the height difference between individuals from the least and most advantaged families is approximately 1.2 cm; among girls, the corresponding difference is about 1.3 cm. Taken together, these results demonstrate a persistent association between parental social origin and offspring body height in contemporary Germany.

1. Introduction

Body height is a dimension of social inequality that remains relatively underinvestigated in contemporary Western societies. While a substantial body of research has examined changes in average height over the course of centuries (Cole, 2003; Holmgren et al., 2019), clearly linking these trends to improvements in living standards, considerably less research has addressed whether social origin continues to be associated with height in recent decades. The prevailing assumption is that the widespread availability of adequate nutrition, high levels of sanitation, and comprehensive medical care, including largely free access to health services, have substantially reduced the influence of social background on physical growth (German et al., 2020; Schönbeck et al., 2013). Under this view, variation in adult height is now largely attributed to genetic endowments rather than to systematic social factors (McEvoy and Visscher, 2009; Silventoinen, 2003). However, at least for contemporary Germany—the largest country in Western Europe and one of the world's leading economies—the empirical evidence is mixed. While some studies fail to identify any association between social origin

and height (Kromeyer et al., 1997), others report small but statistically significant effects (Baten and Böhm, 2010). This study seeks to contribute to this line of research by addressing two central questions. First, are children from socially advantaged families, on average, taller than children from socially disadvantaged families? Second, do children from socially advantaged families grow faster than their peers?

We argue that examining whether body height, a highly consequential individual characteristic, is linked to social origin can provide valuable insights into broader patterns of inequality and contribute to the multifaceted literature on social stratification. To this end, we draw on two large prospective panel datasets that allow us to follow individual students over time. These data not only provide a large number of repeated height measurements but also enable us to analyse individual growth trajectories. Although the data do not permit an analysis of long-term historical trends, they offer unparalleled insights into contemporary Germany. Overall, we contend that this research contributes to a better understanding of how health-related characteristics, such as body height, are associated with social inequality, a dimension that is often overlooked (Kroh, 2021). Given that body height itself is a

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well-established predictor of important life outcomes, including income, educational attainment, and labour market success (Bittmann, 2020; Cinnirella et al., 2011; Kim and Han, 2017; Magnusson et al., 2006), it may be considered a potential mechanism through which intergenerational inequality is reproduced.

2. Theoretical framework and state of research

We begin by outlining potential mechanisms that may explain why parental social origin is associated with the body height of their children. Drawing on previous research and established biological pathways, four mechanisms appear particularly relevant. First, socially advantaged parents—who, on average, earn higher incomes, hold more stable and higher-quality jobs, and possess higher educational credentials—tend to exhibit greater health consciousness and are less likely to engage in substance abuse, particularly the use of alcohol and nicotine (Brunello et al., 2016; Crum et al., 1993). Maternal substance use during pregnancy can have severe adverse effects on fetal development, and postnatal exposure, such as parental smoking around young children, may also impair growth (Truong et al., 2013). Children who grow up with limited exposure to harmful substances are therefore likely to experience better overall health, which may translate into greater body height.

Second, although this mechanism may be comparatively weaker in affluent countries such as Germany, socially advantaged parents are generally better positioned to provide their children with access to high-quality nutrition and other health-promoting resources. While access to sufficient calories is unlikely to be the decisive factor, an argument underscored by the recent rise in obesity, parental education may play an important role. More highly educated parents tend to place greater emphasis on health and balanced nutrition, which can positively influence their children's physical development (Vos et al., 2022); furthermore, income may also play a role (Darmon and Drewnowski, 2015). Third, children raised in socially advantaged families may be better protected from chronic stressors that can negatively affect growth (Evans and Kim, 2013). Stress-inducing experiences, such as parental unemployment or financial insecurity, have been shown to impair physical development, and these risks are less prevalent among families with higher social standing (Baten and Böhm, 2010).

Fourth, genetic factors and assortative mating are likely to be influential. Parental socioeconomic status is partly associated with cognitive ability, which itself is positively correlated with body height; on average, taller individuals also score higher on measures of cognitive performance (Lundborg et al., 2009). Partner selection is not random: individuals tend to form unions with others who have similar levels of education and social status (Luo, 2017). As educational attainment is linked to cognitive ability, and cognitive ability correlates with height, socially advantaged parents—who are, on average, taller—are more likely to have taller offspring due to genetic transmission alone (Keller et al., 2013; Stulp et al., 2017). Although filial height is not determined by a single gene but by a complex interplay of many genetic factors, these processes can generate systematic differences in height across social groups even in the absence of the previously discussed environmental mechanisms. Taken together, these arguments predict a positive association between parental social origin and offspring body height. It is important to note that this question is conceptually distinct from analyses examining whether an individual's own social status later in life (for example, at age 40) is associated with their own body height.

After having outlined the main mechanism that link parental social status to filial body height, specific research findings, especially for Germany, are discussed. One longitudinal study, including children from four to 12 years, does not find any association between parental status and filial height (Kromeyer et al., 1997). However, this study had a very small sample of only 207 children, making it virtually impossible to detect small effect sizes. A more recent study with a very large sample size of more than 250,000 students was able to recover negative effects

of parental unemployment on filial body height, however, this is only a rather limited aspect of social origin, measured only in a single federal state of Germany (Baten and Böhm, 2010). When we turn to historic data, in 1914, quite relevant height differences between social strata can be detected (Wilke et al., 2022). Another study, focussing on the role of food rationing during WW1 agrees with these results (Blum, 2013). Even older data from 1771 indicate even larger height differentials among boys of different social origin (Komlos et al., 1992). Turning to other countries, one study from the UK finds quite relevant height differences among the social strata in 1958 of up to two centimetres, which have been greatly reduced, yet still persist, in the 1991 cohort (Li et al., 2004). Another study from the UK finds that socially benefited children are about 1.4 cm taller than other children at age 11, a finding that is fully explained by parental height (Galobardes et al., 2012). A recent study from Austria finds that height differences between conscripts born between 1998 and 2002 amounts to about 3.3 cm between lowly and highly educated groups, indicating still persisting social differentials when it comes to body height (Waldhör et al., 2023). Results from Spain indicate that height differentials among social classes have been greatly reduced from 1940 to 1994, yet some differentials do still persist (Candela-Martínez et al., 2022). Summarized, the findings indicate that the association between parental social status and filial body height has drastically reduced over time. However, even in recent cohorts, effects can still be detected, sometimes of quite impressive magnitude.

Given the current state of research, we emphasize the advantages of the NEPS data. Although previous studies have examined the association between social origin and body height in Germany, these analyses have either relied on very small samples (Kromeyer et al., 1997) or lacked an individual-level panel structure, instead drawing on aggregated official statistics rather than repeated observations of the same individuals (Baten and Böhm, 2010). In contrast, the National Educational Panel Study (NEPS) provides a recent and exceptionally rich data source for the German context. It includes a large number of children who are followed prospectively over an extended period and offers detailed information on parental social origin as well as a wide range of relevant covariates and potential confounders. We therefore contend that the NEPS data allow us to generate novel and robust insights that extend the existing literature.

Based on our theoretical framework and the available empirical evidence, we formulate the following testable hypotheses:

H₁ : Parental social origin is positively associated with offspring body height.

H₂ : Parental social origin is positively associated with offspring body height growth.

3. Empirical analyses

3.1. Data and sample

All analyses are based on data from the German National Educational Panel Study (NEPS).² The NEPS is Germany's most comprehensive longitudinal research project on educational trajectories across the life course and is implemented using a multicohort sequence design (Blossfeld and Roßbach, 2019). In addition to detailed information on educational processes, the NEPS collects extensive panel data on psychological characteristics, health, and well-being. Family background is measured in considerable detail through surveys of parents. To address our research questions, we draw on two starting cohorts. The primary school cohort (SC2) follows children from their entry into primary education, while the secondary school cohort (SC3) samples students

² This paper uses data from the National Educational Panel Study (NEPS). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network.

immediately after their transition to secondary school (grade 5). Together, these cohorts provide prospective panel data covering ages six to 19, thereby encompassing key developmental stages relevant to physical growth.

The initial sampling frame of the primary school cohort (SC2) comprised 9337 students. Body height was measured in survey waves 4 (2013/14), 5 (2014/15), 8 (2017/18), 9 (2018/19), and 10 (2020/21). Restricting the sample to respondents who reported their height at least once reduces the analytical sample to 7084 individuals. In the secondary school cohort (SC3), the initial sample included 8317 students, with height measured in waves 3 (2012/13), 6 (2015), and 10 (2018). Applying the same inclusion criterion yields a final sample of 6896 students. All remaining missing information was addressed using an imputation procedure.

3.2. Variables and operationalization

In the primary school cohort, body height is reported by parents in centimetres, reflecting the young age of the children. In the secondary school cohort, height is self-reported by the students. Age is calculated at the time of each survey wave on a monthly basis. To operationalize parental social origin, or socioeconomic status (SES), we draw on a wide range of variables collected in the parent questionnaires. In line with our theoretical framework, we conceptualize social origin as a multidimensional construct encompassing economic resources, educational attainment, cultural capital, and occupational status.

First, household economic resources are measured using post-tax household income, adjusted for household size according to the OECD equivalence definition. This adjustment accounts for differences in the number of individuals sharing household resources. The income measure is logarithmized to improve its statistical properties. Second, parental education is captured by the highest educational degree attained by either parent, classified according to the German educational system into four categories: no formal qualification or lower secondary education (*Hauptschulabschluss*), intermediate secondary education (*Mittlere Reife*), higher education entrance qualification (*Abitur*), and tertiary education. Third, occupational status is measured using the highest International Socio-Economic Index of Occupational Status (ISEI) score observed among the parents, ranging from 16 (e.g. cleaner) to 90 (e.g. judge). This approach is chosen because, in many households, mothers are not employed or do not report a valid ISEI score; using the maximum value therefore provides a more reliable indicator of overall household status than an average, which could be biased by missing or unreliable information. Finally, cultural capital is proxied by the number of books in the household, measured on an ordinal scale ranging from 0 (0–10 books) to 6 (more than 500 books).

When parental characteristics are reported in multiple survey waves, we use the median value across all observations for income and ISEI, and the highest observed value for educational attainment. We include several control variables, such as the family's place of residence³ (East versus West Germany), the age of the oldest parent in the household (since socioeconomic status may depend on age, as older parents typically possess greater capital), and migration background: 0 (native), 1 (the student herself was born abroad), 2 (at least one of the parents has been born abroad). This seems to be a relevant control, as immigrants often have fewer capital resources, but they may also possess a different genetic background that can influence height. Finally, we control for nuclear family (binary variable). When the parents report that in at least one survey wave that only one parent was present, this is counted as a single-parent household. Since social origin otherwise lacks typical

³ We have also tested whether there are height differences on a smaller level, using information about districts. However, as our tests showed that the intraclass correlation for these models is very low (below two percent), we have decided to use the simpler models instead, controlling only for East and West.

confounders, no additional control variables are utilized.

3.3. Strategy of analysis

As a first step, we construct a comprehensive measure of parental social origin. In principle, this could be achieved by including all previously described indicators of social origin directly in the regression models. However, such an approach entails several drawbacks, including multicollinearity and substantial challenges in interpretation. These issues are particularly pronounced when estimating interactions between age and social origin, as models with multiple correlated indicators quickly become difficult to interpret. We therefore propose a statistically robust and parsimonious solution. First, we conduct a principal component analysis to assess whether the indicators of social origin load onto a single latent dimension. As all indicators load strongly on one factor with an eigenvalue greater than one, we proceed by estimating a structural equation model using Empirical Bayes means to generate a continuous index of social origin (Ip and Molenberghs, 2010). The resulting measure is approximately normally distributed and subsequently z-standardized, yielding a single, easily interpretable indicator of parental social origin. To ensure comparability across the two cohorts, we apply a weighting procedure when constructing the index. This approach guarantees that the substantive meaning of the social origin scores remains identical across cohorts, even if the distributions of the underlying variables differ between samples.

Having established this measure, we proceed with the main analyses. In the first step, we examine whether students' body height is, in general, associated with parental social origin. Because individuals are observed repeatedly over time, we estimate multilevel linear regression models with fixed effects for survey waves. This strategy allows us to assess the association between social origin and body height net of age, survey-specific effects, and additional potential confounders.

In the second step, we investigate whether parental social origin affects the rate at which students grow over time. To this end, we estimate fixed-effects panel regression models that include an interaction between social origin and age at the time of the survey. As social origin is time-invariant by construction, its main effect is absorbed by the individual fixed effects; however, the interaction term remains identifiable. A positive coefficient on this interaction indicates that growth rates increase with higher levels of social origin. FE regressions are statistically highly robust, as all time-constant factors are automatically accounted for, such as gender, migration background, or even genetic differences between students. This attractive property of the FE-estimator renders the results highly robust, even when many relevant controls cannot be measured directly (Brüderl and Ludwig, 2015).

Finally, we analyse final adult height. In the secondary school cohort, students are approximately 19 years old at the last measurement occasion, an age at which the growth process is largely complete. To assess whether parental social origin is associated with final height, we estimate a linear ordinary least squares (OLS) regression model using data from the final survey wave only. All analyses are conducted separately for boys and girls to account for gender-specific growth patterns.

All statistical analyses are performed using Stata 18.0. To address item nonresponse, we apply multiple imputation using chained equations. Predictive mean matching is used for continuous and binary variables (Austin and Van Buuren, 2023), ordinal regression models for parental education, and multinomial logistic regression for migration background. A range of auxiliary variables is included to improve the quality of the imputations, including academic performance, which is correlated with parental social origin, cognitive ability, and body height. To ensure high precision, we generate 100 imputed datasets. Additional user-written Stata commands employed in the analyses include *vioplot*⁴,

⁴ <https://ideas.repec.org/c/boc/bocode/s456902.html>

*binscatter*⁵, and *mimrgns* (Klein, 2014).

4. Results

We begin by presenting descriptive statistics to provide an overview of the NEPS data. Fig. 1 displays violin plots of body height by age and cohort. In all age groups, height is approximately normally distributed. At younger ages, average height levels are very similar for girls and boys; however, gender differences widen over time and become most pronounced at the end of puberty. To assess the quality and representativeness of the NEPS height data, we compare the reported height distributions with official statistics. The results of this comparison are presented in the appendix (Table A1). Differences between the NEPS and official data are small across most survey waves (with a few exceptions, where differences can amount to at most 4.6 cm), indicating that the NEPS provides high-quality and largely representative information for the Federal Republic of Germany for the majority of all survey waves. The distribution of the social origin index is also shown in the appendix (Figure A1). Descriptive statistics for all other variables are reported in Table 1. Note that binary or categorical variable means can be interpreted as shares (for example, 51% of students in the primary school cohort are girls).

To gain a first impression of the association between body height and parental social origin, we present a scatterplot with a fitted regression line pooling all cohorts, ages, and both genders (Fig. 2). The figure reveals a pronounced positive association between social origin and height up to approximately the average level of social origin (zero on the standardized scale). Beyond this point, the slope flattens considerably, indicating that increases in social origin above the mean are associated with only marginal gains in body height and eventually reach a plateau.

We next examine the overall association between parental social origin and body height using multilevel regression models. The results are reported in Table 2. In the primary school cohort, the estimated coefficient for boys is approximately 0.29, indicating that a one standard deviation increase in social origin is associated with an average increase in height of about 0.29 cm. This effect is statistically significant at the 5% level. For girls, the estimated coefficient is smaller (0.13) and not statistically significant. A similar pattern emerges in the secondary school cohort. Here again, the association between social origin and height is statistically significant for boys but not for girls. Taken together, these findings suggest that parental social origin is relevant for boys' height but not for girls' height in the cross-sectional models, leading us to partially support Hypothesis 1. While the coefficient on age is not straightforward to interpret—given that survey wave indicators are also included as controls—the results confirm that older children are taller on average. In addition, students with a migration background are, on average, shorter than their peers. Single parenthood exhibits a statistically significant negative association with height only for girls in the secondary school cohort.

Then we continue with the fixed-effect regression models, where we test whether socially benefited children grow faster than other children. As all time-constant variables automatically drop out of these models, there is no need to include time-constant controls. The only relevant predictors are age and the interaction of age with social origin. The results are shown in Table 3.

The coefficient of age is statistically significant at the 0.1% level in all models. For example, among boys in the primary school cohort, average growth amounts to approximately 6.2 cm per year. The interaction between age and social origin is not statistically significant for boys in the primary school cohort but is highly significant for all other groups. This indicates that students from families with higher social origin tend to grow more within a given year. The strongest effect is observed among boys in the secondary school cohort, for whom annual

growth increases by about 0.20 cm when parental social origin is one standard deviation higher. In light of these findings, we accept Hypothesis 2. It is important to note, however, that growth is observed in this study only between ages eight and 19. Faster growth during this period does not necessarily translate into greater final adult height if initial height levels differ across social groups.

Finally, to better understand the association between parental social origin and body height at a stage when height is essentially fixed, we focus on the last measurement wave of the secondary school cohort, when students are approximately 19 years old. We estimate linear (OLS) regression models including all control variables and compute predicted values of height across levels of social origin. To allow for a flexible specification without imposing a functional form on the association, we recode the continuous social origin index into septiles (with 1 indicating very low social origin and 7 indicating very high social origin) and use this categorical specification. The results are presented in Fig. 3.

The results reveal a clear positive association between parental social origin and final body height, consistent with the findings from the previous models. While this association is approximately linear across most of the distribution of social origin, it tapers off at very high levels of origin. These general patterns are observed for both boys and girls. Among boys, the difference in predicted final height between individuals from the least and most socially advantaged families is approximately 1.24 cm; among girls, the corresponding difference is about 1.32 cm. For both genders, the height differences between the two extreme septiles are statistically significant at the 5% level.

5. Discussion

Although not all coefficients across all statistical models reach conventional levels of statistical significance, the overall pattern is clear: children from socially advantaged families are, on average, taller and exhibit faster growth. In the models estimating average height over childhood and adolescence, the association with social origin is more pronounced for boys than for girls, for whom the effect is not statistically significant in the pooled models. Importantly, this gender difference does not appear to be spurious, as the association between parental social origin and height persists into early adulthood for both genders and thus represents a stable, long-term effect. In this respect, our findings are broadly consistent with the German study by Baten and Böhm (2010), who report that unemployment, a condition closely related to social origin, is associated with shorter body height. By contrast, Kromeyer et al. (1997) do not find a relationship between social origin and height; however, their analysis is based on a very small sample. Given the exceptionally large sample size available in our panel data, it appears that the effect sizes, while modest, are persistent and robust. When comparing individuals from the most socially disadvantaged and most advantaged groups, the height difference amounts to slightly more than one centimetre. While this might seem large, this is smaller than differences from Austrian conscripts, where the height difference of a rather recent birth cohort (1998–2002) did amount to more than three centimetres (Waldhör et al., 2023). For the 1958 birth cohort in the United Kingdom, the height difference between the most extreme social groups amounts to about 2.4 cm (measured at age 33), indicating that our findings are smaller than that (Li et al., 2004). Overall, our results are in line with evidence from other European contexts, including studies from Austria, the United Kingdom and Spain, suggesting that social gradients in body height persist even in highly developed welfare states (Waldhör et al., 2023, Li et al., 2004, Candela-Martínez et al., 2022).

While our findings demonstrate that an association between body height and parental social origin persists in contemporary Western societies, the underlying mechanisms cannot be directly examined with the available data. In particular, genetic factors, potentially among the most important determinants of height, cannot be assessed, as the NEPS does not include genetic information or measures of parental height. At

⁵ <https://michaelstepner.com/binscatter/>

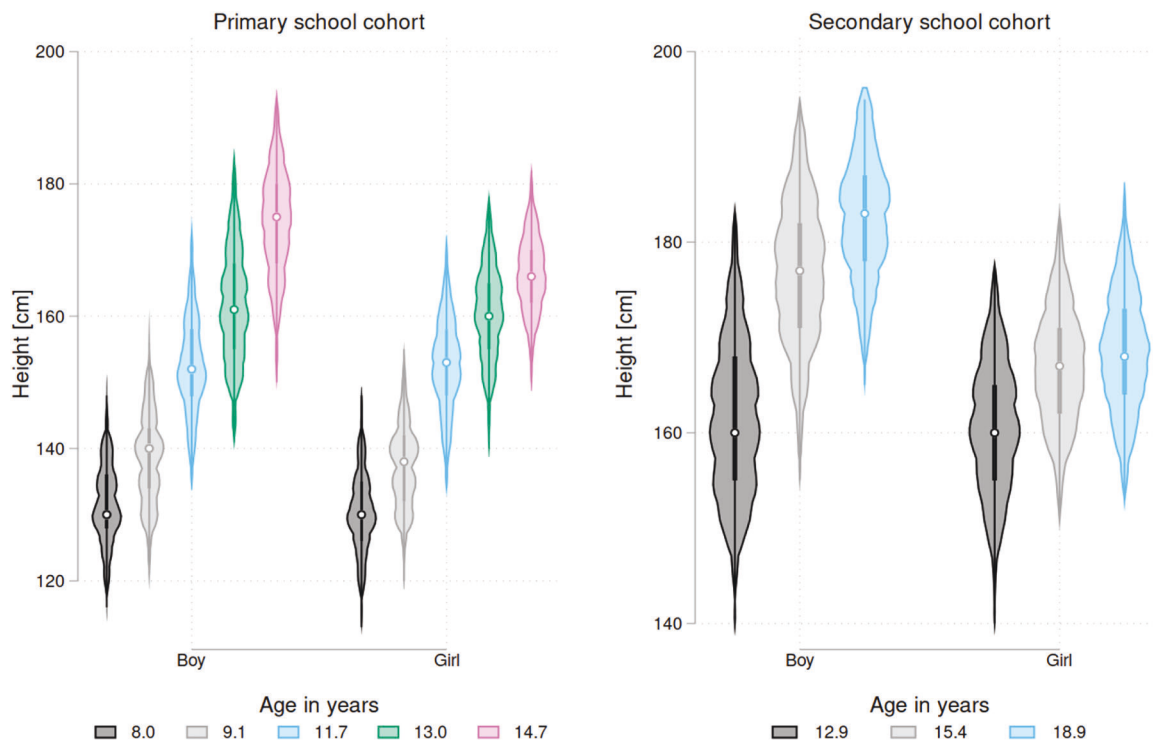


Fig. 1. Distribution of body height by cohort, gender, and time of survey. Source: NEPS SC2/3, imputed data (M=100). Extreme outliers excluded for a clearer depiction.

Table 1 Descriptive sample statistics.

	Primary school cohort					Secondary school cohort				
	mean	sd	med	min	max	mean	sd	med	min	max
Female student [#]	0.51	0.50	1	0	1	0.48	0.50	0	0	1
Height (t1)	131.2	7.05	130	100	165	160.9	8.51	160	129	190
Height (t2)	137.9	7.45	138	95	170	171.9	8.77	171	147	195
Height (t3)	152.7	7.89	152	114	190	175.7	9.55	175	148	195
Height (t4)	161.1	8.57	160	50	196					
Height (t5)	170.0	8.58	170	117	205					
Age (t1)	8.03	0.37	8.01	6.33	9.92	12.9	0.52	12.9	10.4	15.6
Age (t2)	9.09	0.40	9.09	7.09	11.5	15.4	0.52	15.3	12.8	18.1
Age (t3)	11.7	0.35	11.7	10.7	13.5	18.9	0.53	18.8	16.6	21.9
Age (t4)	13.0	0.40	13.0	11.4	14.8					
Age (t5)	14.7	0.36	14.7	13.6	16.1					
Social origin (std)	0.15	0.97	0.11	-3.20	3.72	-0.15	1.00	-0.21	-3.33	3.83
Education mother ^{#*}										
Low	0.18	0.39	0	0	1	0.29	0.45	0	0	1
Intermediate	0.31	0.46	0	0	1	0.32	0.47	0	0	1
High	0.19	0.39	0	0	1	0.15	0.35	0	0	1
Tertiary	0.32	0.47	0	0	1	0.24	0.43	0	0	1
Education father ^{#*}										
Low	0.11	0.32	0	0	1	0.18	0.38	0	0	1
Intermediate	0.36	0.48	0	0	1	0.43	0.50	0	0	1
High	0.25	0.43	0	0	1	0.21	0.40	0	0	1
Tertiary	0.28	0.45	0	0	1	0.18	0.39	0	0	1
Parental ISEI*	55.7	15.6	54	16	90	52.0	16.4	53	16	90
Log. equivalent HH income*	7.42	0.44	7.42	4.87	10.1	7.29	0.45	7.30	5.47	10.8
Number of books at home*	4.26	1.26	4	1	6	4.23	1.42	4	1	6
Age of older parent	40.0	5.87	40	22	75	44.9	5.65	45	26	76
Migration status [#]										
Native	0.79	0.41	1	0	1	0.76	0.43	1	0	1
Pupil born abroad	0.020	0.14	0	0	1	0.045	0.21	0	0	1
At least one parent born abroad	0.19	0.40	0	0	1	0.20	0.40	0	0	1
Living in East Germany [#]	0.15	0.36	0	0	1	0.19	0.40	0	0	1
Single parent [#]	0.25	0.44	0	0	1	0.27	0.44	0	0	1
Individuals	7084					6896				

Source: NEPS SC2/3, imputed data(M=100). * Components of social origin. # Mean can be interpreted as a share

the same time, it appears unlikely that other mechanisms, especially nutrition, play a major role in explaining the observed social gradients in

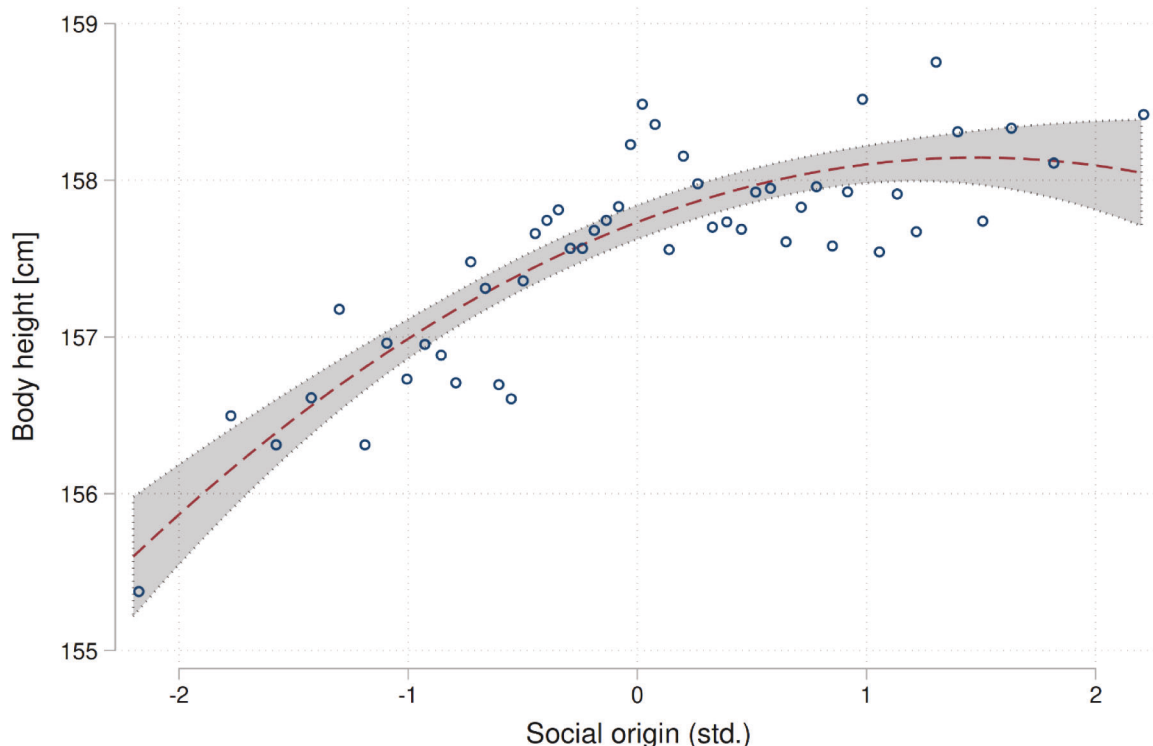


Fig. 2. Scatterplot between body height and social origin. Source: NEPS SC2/3, imputed data (M=100). Results residualized on gender, age, and cohort. Data points have been binned using binscatter for a clear depiction. 95% confidence interval included for the quadratic fit regression line.

Table 2
Multilevel regression models.

	Primary school cohort		Secondary school cohort	
	Boys	Girls	Boys	Girls
Social origin (std)	0.294* [0.012,0.577]	0.130 [-0.114,0.375]	0.308* [0.018,0.597]	0.226 [-0.045,0.497]
Age in years	5.357*** [4.429,6.286]	2.425*** [1.645,3.206]	1.899*** [1.366,2.433]	0.602** [0.149,1.056]
German native	Ref.	Ref.	Ref.	Ref.
Immigrant	-0.432 [-2.348,1.485]	-2.521*** [-4.020,-1.021]	-1.561** [-2.695,-0.427]	-1.021 [-2.151,0.108]
Parents are immigrants	-0.691* [-1.367,-0.015]	-0.796** [-1.377,-0.215]	-1.276*** [-1.920,-0.631]	-1.718*** [-2.301,-1.135]
Living in East Germany	-0.101 [-0.799,0.596]	-0.326 [-0.942,0.291]	0.037 [-0.674,0.747]	0.421 [-0.202,1.043]
Age of older parent	0.027 [-0.019,0.073]	0.036 [-0.002,0.074]	-0.006 [-0.063,0.050]	-0.042 [-0.092,0.009]
Single parent	-0.103 [-0.680,0.473]	-0.139 [-0.656,0.378]	-0.086 [-0.772,0.599]	-0.640* [-1.242,-0.037]
Time point 1	Ref.	Ref.	Ref.	Ref.
Time point 2	0.956 [-0.137,2.049]	4.196*** [3.277,5.116]	10.612*** [9.279,11.946]	5.085*** [3.959,6.210]
Time point 3	1.390 [-1.979,4.760]	13.466*** [10.602,16.329]	9.597*** [6.370,12.824]	4.610*** [1.887,7.333]
Time point 4	3.328 [-1.305,7.961]	17.808*** [13.911,21.704]		
Time point 5	6.538* [0.380,12.695]	19.617*** [14.428,24.806]		
Constant	87.709*** [80.214,95.203]	109.908*** [103.532,116.24]	137.368*** [130.254,144.48]	155.001*** [148.845,161.15]
Observations	17,310	18,110	10,671	10,017
Individuals	3,462	3,622	3,557	3,339

Source: NEPS SC2/3, imputed data (M=100). 95% confidence intervals based on robust standard errors in brackets. * p < 0.05, ** p < 0.01, *** p < 0.001

height. Never before in human history have societies been as affluent as present-day Germany, where access to sufficient and high-quality food is largely ensured, even for socially disadvantaged families. Current public

health challenges, such as the obesity pandemic, suggest that unrestricted access to calories rather than nutritional deprivation has become the dominant issue, making it improbable that malnutrition accounts for

Table 3
FE Regression models.

	Primary school cohort		Secondary school cohort	
	Boys	Girls	Boys	Girls
Age in years	6.23*** [6.18,6.27]	5.49*** [5.45,5.53]	3.39*** [3.34,3.45]	1.33*** [1.29,1.37]
Age # Social origin (std)	0.02 [-0.03,0.06]	0.10*** [0.06,0.14]	0.20*** [0.14,0.26]	0.17*** [0.12,0.21]
Constant	81.23*** [80.78,81.68]	87.43*** [87.03,87.84]	120.35*** [119.48,121.22]	144.85*** [144.23,145.47]
Observations	17,310	18,110	10,671	10,017
Individuals	3462	3622	3557	3339

Source: NEPS SC2/3, imputed data (M=100). 95% confidence intervals based on robust standard errors in brackets. * p < 0.05, ** p < 0.01, *** p < 0.001

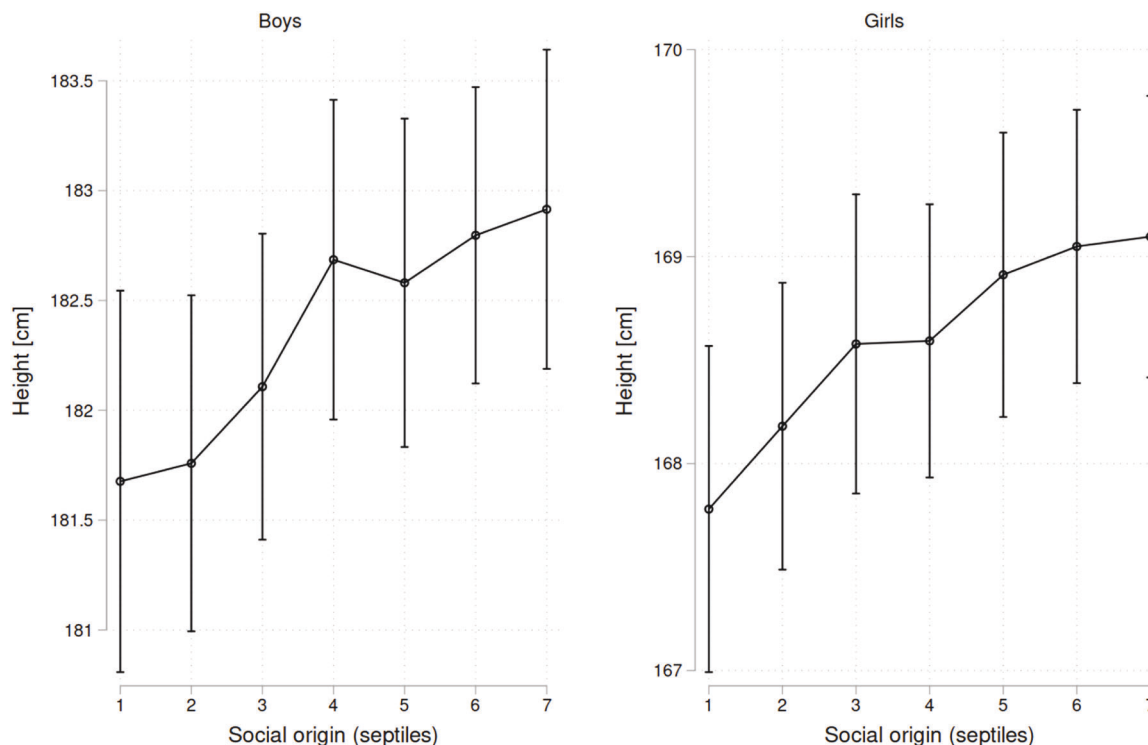


Fig. 3. Relation between social origin and body height in the last survey wave of the secondary school cohort (at age 19). Source: NEPS SC2/3, imputed data (M=100; N = 3557/3339). 95% confidence intervals included. Control variables: age, place of residence, max. parental age, migration background, single parent. Septile 1: lowest social origin.

socially patterned differences in height (Hoebel et al., 2022; Kimm and Obarzanek, 2002).

The study by Baten and Böhm (2010) nevertheless provides informative clues, as their results indicate a negative association between offspring height and parental unemployment. While unemployment in Germany is unlikely to lead to nutritional deprivation, psychological stress and related mechanisms may be relevant. Although genetic endowments are fixed at conception, epigenetic processes (through which gene expression can be altered by environmental conditions) may play an important role. Stress has been shown to affect such epigenetic mechanisms, raising the possibility that chronic exposure to poverty-related stress could influence growth by modulating the expression of growth-related genes (Mousikou et al., 2023). Physiological details of this process have also been studied in mice (Foertsch et al., 2017). Although this mechanism cannot be tested directly in our study, it offers a potentially fruitful avenue for future research. Importantly, the effect sizes identified in our analyses are modest. This suggests that, although the association between social origin and body height persists, it is considerably smaller than it likely was in earlier historical periods. For example, differences amounted to about 4 cm between the lowest

and highest social strata in Stuttgart in 1771 (Komlos et al., 1992), and even around 1900, differences up to 4 cm were reported between lower rank soldiers of different social origins (Blum, 2013). Body height therefore does not constitute a salient marker by which individuals from different social strata can easily be distinguished; a development that can be regarded as positive. Nevertheless, when operating across large populations, even small differences in height may be consequential, particularly given the well-documented links between body height and occupational success (Bittmann, 2020; Cinnirella, 2011; Thompson et al., 2023). Consequently, body height should not be entirely overlooked as a dimension of social inequality, even in modern and affluent societies.

An additional finding, suggested by several of the graphical analyses, is that social origin matters most at the lower end of the socioeconomic distribution. In this range, the association between social origin and height is strongest, whereas it diminishes once an average or above-average standard of living is attained. Why exactly this pattern arises remains unclear in the current setting, as the study is neither genetically informed, nor exact living conditions (such as available nutrition) were measured. While it seems unlikely that in highly developed country such

as Germany malnourishment, especially in the early childhood, is common in the lower social strata, it cannot be ruled out at this point. Given that, we refrain from offering a general explanation.

Finally, we discuss several limitations of this study. First, all height measurements are self-reported, either by parents or by the students themselves. Self-reported data may introduce measurement error and potentially bias the estimates. Nevertheless, we believe that such distortions are likely to be limited. Comparisons between the NEPS height data and official statistics indicate only small deviations. Moreover, because height is measured repeatedly for the same individuals, random measurement error is expected to average out over time, which represents a substantial advantage of our panel design compared with studies relying solely on cross-sectional data. However, we cannot entirely rule out the presence of systematic reporting error—for instance, if parents from socially advantaged families consistently overestimate their children's height.⁶

Second, although our measure of social origin incorporates a wide range of indicators, there is no universally accepted definition of this concept, and alternative operationalizations may emphasize different dimensions. We argue, however, that our multidimensional approach captures several core aspects of social origin and thereby provides a robust representation of the construct. Third, while the NEPS offers a large and rich dataset, it does not perfectly represent the entire population of pupils in Germany. In the absence of a comprehensive national student register, it is not possible to directly assess the extent to which the sample deviates from the target population. Although this limitation may affect the descriptive statistics, it is less problematic for the multivariable analyses, as many relevant characteristics, such as region of residence and migration background, are explicitly controlled for in the estimation models. Also related to the datasources is that the youngest ages in the study are about eight years, meaning that not the entire growth-process can be investigated. This is especially relevant since children from lower socioeconomic backgrounds are often already smaller at birth (Howe et al., 2012), meaning that it might be difficult to compensate for this initial disadvantage over the following years. In other words, main social height inequalities might already be present when the child is born and our study might not pick this up due to temporal design of the two cohorts. Other studies might want to add data sources that start at birth, so that no developmental phase is

omitted from the analyses. In any case, this limitation should not be severe as the most relevant outcome, the final body height when individuals stop growing, is included in the window of observation.

6. Conclusion

This study examines the association between parental social origin and students' body height using longitudinal panel data from two large German cohorts covering ages eight to 19. We show that parental social origin is positively associated with body height. Children from socially advantaged families not only grow faster than their peers but also attain greater final adult height. The gap in final height between individuals from the most socially disadvantaged and the most advantaged families exceeds 1.2 cm. These findings hold for both boys and girls and indicate that body height remains a relevant, albeit modest, dimension of social inequality in contemporary Germany.

Data and code

Data are available for researchers after registration from <http://dx.doi.org/10.5157/NEPS:SC2:11.0.0> and <http://dx.doi.org/10.5157/NEPS:SC3:13.1.0>. Complete Stata programming do-files are available from the authors upon request.

CRediT authorship contribution statement

Felix Bittmann: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

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Declaration of Competing Interest

The authors state that there is no conflict of interest. This study did not receive any special funding.

Appendix A

Table A1
Comparison of NEPS height measurements to official statistics (in brackets)

Timepoint	Average Age	Boys	Girls
Primary school cohort			
1	8.0	130 [130.8]*	130 [129.5]*
2	9.1	140 [136.4]*	138 [135.3]*
3	11.7	152 [149.4]*	153 [151.0]*
4	13.0	161 [159.1]*	160 [159.5]*
5	14.7	175 [170.4]*	166 [163.8]*
Secondary school cohort			
1	12.9	160 [159.1]*	160 [159.5]*
2	15.4	177 [175.2]*	167 [165.1]*
3	18.8	182.4 [181.8] [#]	168.6 [167.7] [#]

References: * Robert Koch-Institut: https://www.gbe-bund.de/pdf/3_Koerperlaenge_erw_auf1.pdf (reporting and comparing medians)

[#] German Federal Statistical Office: <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Gesundheitszustand-Relevantes-Verhalten/Tabellen/liste-koerpermasse.html#119168> (reporting and

⁶ To test this, we have included the Big-5 personality trait “Conscientiousness” in the models for the secondary school cohort, where his construct has been measured. However, the conclusions of the models never change and the coefficient of conscientiousness is never statistically significant. The assumption is that students with high levels of conscientiousness report their height diligently.

comparing arithmetic means)

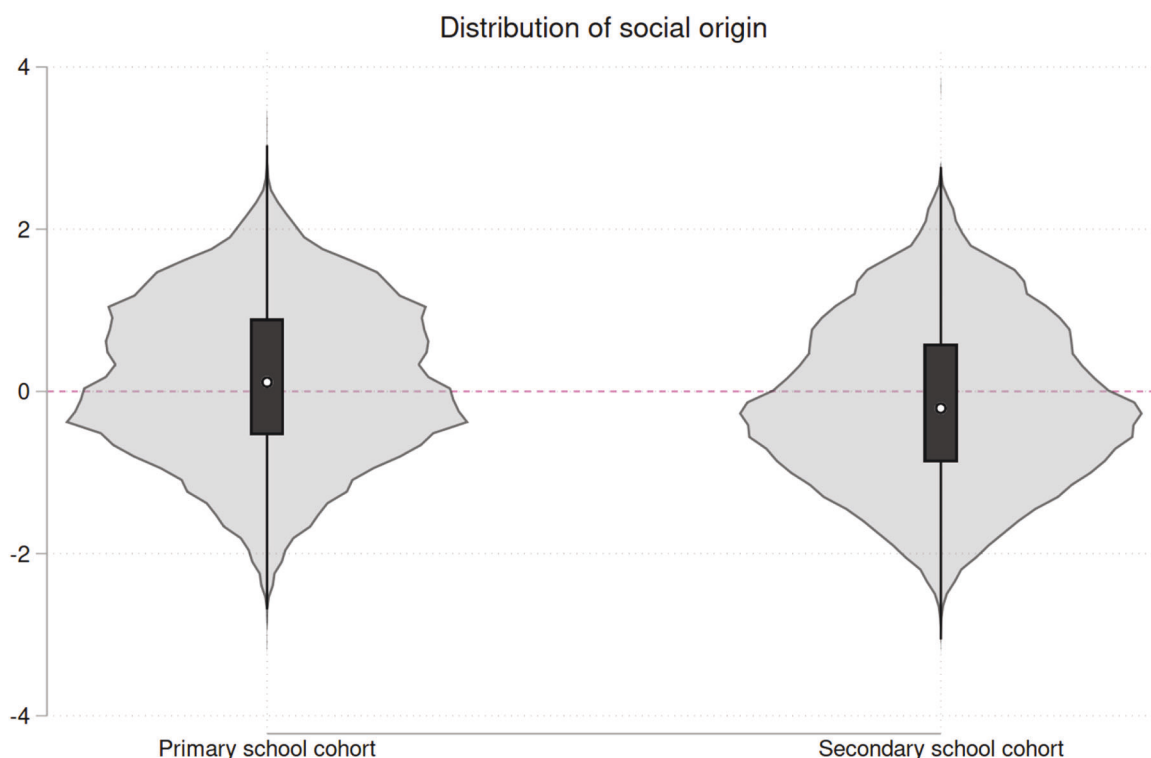


Figure A1. Distribution of social origin by cohort
Source: NEPS SC2/3, imputed data (M=100).

Data availability

The authors do not have permission to share data.

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