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How are social origin, destination and mobility linked to physical, mental, and self-rated health? Evidence from the United States

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Abstract
For decades, scholars have been exploring persistent inequalities in health by studying the roles of origin and destination socioeconomic positions (SEP), and the importance of social mobility trajectories from childhood to adult life in individuals' wellbeing. However, this literature does not produce consistent and systematic findings on the relative importance of origin and destination SEP and independent social mobility effects. One of the main reasons for this is a set of methodological choices and decisions which researchers make. Arguably, one of the most critical aspects of research design is the operationalisation of SEP and the selection of health outcomes, usually without accounting for initial values of the health indicators employed. Using a nationally representative longitudinal dataset (Add Health) for the United States and diagonal reference models, in the present study, we examine how the choice of SEP in terms of educational, occupational, and income attainment, and the choice of health measures in terms of obesity, depressive symptoms, and self-rated health, influence findings on the origin and destination effects, as well as the health implications of social mobility. We also address the health selection problem by explicitly accounting for adolescents' health in terms of each health outcome considered. Our results indicate that both choosing SEP and health measures, and accounting for social mobility and adolescent health have a noticeable impact on the relative importance of social origin and destination positions for health outcomes. We do not find evidence that social mobility has an independent effect on health, or that individuals' previous health status moderates this association.

Keywords Social mobility · SEP · Physical health · Mental health · Diagonal reference models · The United States

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1 Introduction

Understanding the consequences of intergenerational social mobility on individuals' well-being has been one of the foundational issues in sociology since the end of the nineteenth century (Durkheim 1897; Hollingshead et al. 1954; Sorokin 1927). During that historical period, occupational structure was rapidly changing, accompanied by corresponding spatial and social mobility of individuals across generations and over the course of their lives (Lipset and Zetterberg 1959). Researchers were primarily concerned with upward social mobility's implications on individuals' lives associated with socioeconomic progress and improving living standards. In the twenty-first century persisting health inequalities and intergenerational reproduction of socioeconomic position (SEP), the greater availability of data, and novel methodological approaches and statistical software have been among the factors leading to a renewed scholarly interest in the topic of the health implications of social mobility (Bukodi et al. 2020; Kaiser and Trinh 2021; Mackenbach 2019; Präg 2019; Präg and Gugushvili 2021; van der Waal et al. 2017; Zelinska et al. 2021).

Over the decades, public health and social epidemiology research have produced unequivocal evidence on the enduring effect of childhood SEP on later-life health outcomes (Beebe-Dimmer 2004; Hughes et al. 2017). However, the relative importance of the origin and destination SEP for health is still not well understood. There are multiple channels through which childhood and adulthood SEP may influence adults' health (Marmot 2005; Phelan et al. 2010). Health outcomes may be affected directly by the early childhood environment, such as inadequate nutrition or poor housing conditions leading to long-term health problems later in life (Barker 1999; Preston et al. 1998). The direct impact of low parental SEP may become visible at different stages of an individual's life, depending on triggering factors and how quickly adverse influences accumulate (Ben-Shlomo and Kuh 2002). A high childhood SEP, in turn, can influence future health outcomes indirectly through its role in determining adult educational, occupational, and income attainment (Haas 2006). Other indirect channels for the influence of origin SEP on health in adulthood are norms and behaviours passed from parents to children related to healthy diet, regular exercise, or substance abuse (Gugushvili et al. 2018; Singh-Manoux and Marmot 2005). These habits may determine health outcomes even in the case of individuals whose SEP changes during the course of their lives.

After accounting for the origin and destination SEP and the enduring effects of norms and behaviours, there are reasons to hypothesise that social mobility may also be linked to variation in adult health. Socially mobile individuals may experience different stress levels as they move up or down from their childhood positions (Gugushvili et al. 2019a; Jonsson et al. 2017; Schuck and Steiber 2017). The dissociative thesis predicts that both upwardly and downwardly mobile individuals have worse health outcomes. That said, according to the "falling from grace" perspective, the experience of downward mobility is more important than that of upward mobility because individuals find themselves in inferior and, in their view, undeserved socioeconomic conditions. The literature review on health and well-being consequences of social mobility suggests that the evidence on systemic and significant mobility effects on health is mixed. One of the main reasons for this is that scholars use different SEP and social mobility measures, and explore the impact of origin, destination, and mobility on various health outcomes.

In this study, we employ a nationally representative longitudinal dataset and an appropriate methodological framework to explore and understand how the choice of SEP and health measures influences findings on the origin and destination effects, and health

implications of social mobility. We separate mobility effects, both upward and downward, from the origin and destination SEP for three different measures related to educational attainment, occupational status, and level of income, and look at three health outcomes related to physical health—obesity, mental health—depressive symptoms, and self-rated general health. Additionally, to limit the possibility of confounders potentially biasing our estimates, we account for a set of characteristics in our multivariable models, including individuals' sociodemographic variables and measures reflecting childhood neighbourhood conditions. Importantly, we address the health selection problem in social mobility research by explicitly controlling for childhood health for each outcome measure considered. To summarise, one of the main goals of this study is to identify any noticeable differences in patterns arising due to the choice of a particular combination of SEP and health outcome measures.

2 Background

2.1 Why does the selection of SEP measures matter?

Past research has shown that both parental (origin) and individuals' (destination) SEP play an essential role in determining numerous health outcomes, including allostatic load, depressive symptoms, obesity, and health-related behaviours (Dennison, 2018; Gugushvili et al., 2020; Monden & de Graaf, 2013; Präg & Richards, 2019; van der Waal et al., 2017; Gugushvili et al. 2019b). However, SEP is not a unidimensional construct, and its operationalisation depends on researchers' theoretical premises and the availability of data. Frequently, SEP is derived from information about attained education levels, occupational class or status (primarily used by sociologists), and income (used mainly by economists). The multitude of SEP measures used, combined with the use of different datasets and statistical methods, makes it difficult to assess how the choice of these various SEP indicators impacts the estimated importance of childhood and adult SEP on health and to assess if there are independent effects of social mobility. Based on past evidence, the relative importance of childhood characteristics varies greatly depending on the choice of the main covariates and outcome measures (Präg and Richards 2019; van der Waal et al. 2017). Furthermore, factors such as respondents' age, gender, and geographical location may also contribute to the discrepancies in past findings (Präg and Gugushvili 2020; Steiber 2019).

One of the goals of the present study is to account for different SEP measures using the same dataset and identical model specifications. This approach would allow us to compare results across different origin and destination measures and identify a net effect of social mobility on health. Why should the origin and destination SEP and corresponding mobility cause different effects based on the selection of education, occupation, or income for analysis? All of these variables measure various aspects of SEP with related resources, advantages, and disadvantages known to have particular importance for health. If we start with educational attainment, this is associated with greater knowledge and awareness of health-conducive lifestyles, such as eating healthy food, exercising regularly, and avoiding unhealthy behaviours, e.g. smoking and drinking. Better educated individuals are also more likely to refer to health services when needed and engage in preventive health measures, such as health checks and immunisation (Lutfey and Freese 2005). It is also clear that children with better educated parents, especially mothers, benefit from the described health-related practices. Therefore, parental education can have a lasting effect on their

children's health in adulthood, especially if children continue to follow the health-conducive lifestyles to which they were socialised.

Occupational attainment can have an independent health effect because occupational groups to which an individual belongs indicate the stability and security of their own employment and corresponding sources of income, or that of their parents during their childhoods (Goldthorpe et al. 1980). Occupations also reflect differences in occupational hazards (Mehrdad 2020), the type of lifestyles in which individuals are engaged, and the type of social network that individuals are part of during adolescence and adult life (Glendinning et al. 1995; Gugushvili et al. 2017; Petev 2013). Lastly, income is probably the most explicit measure of SEP in relation to health because it reflects how well individuals and households can satisfy their own needs for food, clothing, shelter, education, health insurance, and recreation (Marmot 2005). Higher income of both an individual or their parents would allow individuals to experience better material conditions with positive health effects (Emerson et al. 2006). Although the SEP measures described are associated with each other, they all maintain an independent impact on health outcomes (Hoffmann et al. 2019). It has been argued that income has a stronger link with health than other SEP measures. Yet, health selection might be an essential matter in this association; those who cannot work for health reasons are also more likely to have lower incomes (Torssander and Erikson 2010).

2.2 Why does the selection of health outcomes matter?

The central differentiating aspect of various health outcomes in research on the health consequence of social mobility is the distinction between individuals' physical health and their mental health. It is well established that life course exposures conditioned by individual SEP during childhood and adulthood shape individual physical health (Holland et al. 2000; Hughes et al. 2017). On average, the more time individuals spend throughout their lives in a more advantageous SEP, the better their physical health is, compared to those who spend more time in a less advantageous SEP. The relative importance of the origin and destination SEP on physical health depends on individuals' age, and the time they moved from one SEP to another (Bartley and Plewis 2007; McCrory et al. 2015).

Different mechanisms may be in place when it comes to mental health outcomes related to individuals' SEP. While time spent in a specific SEP can be engraved in the body's wear and tear, the human brain is more capable of overcoming mental health issues caused by particular life experiences in association with SEP change (Beck et al. 1998). It is also probable that the hypothesised positive or negative effects of social mobility on mental health might last for a relatively short time before individuals psychologically adjust to a new environment and return to their set-point psychological health (Weiss et al. 2008). Furthermore, the main social science theories on the consequences of social mobility explore psychological mechanisms, such as individuals' perceptions of the uncomfortable environment they have entered after experiencing upward mobility, the sense of loss and unfairness after experiencing downward mobility, or feelings of gratitude after achieving more than expected considering the origin disadvantages (Gugushvili et al., 2019a). Consequently, if individuals' physical health is affected by social mobility, then the mobility effect is channelled mainly via mental health. In turn, there is overwhelming evidence that mental health has a direct impact on physical health (Ohrnberger et al. 2017).

When it comes to specific health measures analysed in the literature on health consequences of social mobility, individuals' body mass index (BMI) is an indicator often

employed by scholars (van der Waal et al. 2017). BMI is a physical health indicator derived from an individual's observed bodily weight and height. This health measure is associated with higher all-cause mortality, cardiovascular issues, and other health problems (Di Angelantonio et al. 2016; Murray et al. 2011). The role of childhood characteristics in individuals' BMI scores is prominent, as individuals' height is significantly shaped by parental education and other origin characteristics (Chen and Li 2009; Jarosz and Gugushvili 2020). On the other hand, there is a strong social gradient in individuals' adult weight. Those on the lower rungs of the social hierarchy usually have fewer resources to maintain a healthy weight (Rodriguez-Caro et al. 2016).

The mental health indicators are also often used in research on social mobility implications for health and, as mentioned above, they come closest to the predictions of social mobility theories (Gugushvili and Präg 2021; Houle and Martin 2011). The composite measures of psychological health are usually considered more reliable indicators than estimates based on a single aspect of mental health. Finally, probably the most widely tested health outcome measure in the literature is self-rated health. This measure's main advantage is that it combines the physical and mental aspects of health, and serves as a good proxy for individuals' overall health status (Lorem et al. 2020).

2.3 Why should we account for health selection?

In the light of past research, when disentangling the influence of origin and destination characteristics and social mobility on health, it is of particular importance to address the mechanisms of health selection which link health in childhood to both adulthood health and individuals' social mobility chances and attained SEP (Anderson 2018; Haas 2006; Gugushvili et al. 2021). There are two main aspects to consider. First, poor health may limit individuals' opportunities to experience upward mobility and may even contribute to individuals attaining a lower SEP than their parents did. For instance, it is likely that health limits individuals' educational attainment which, in turn, determines success in the labour market. If childhood health problems persist later in life, this would also put individuals in a disadvantageous position while competing for jobs in the labour market. Poor childhood health can limit higher earnings possibilities due to health-induced lower productivity (Aigner and Cain 1977). This vicious cycle of adverse outcomes can be potentially addressed through well-functioning welfare state institutions and antidiscrimination regulations (Campos-Matos and Kawachi 2015).

The second aspect related to health selection occurs when a background characteristic, for example living in a deprived area, shapes both origin and adult health and determines mobility chances (Haas 2006; Lundberg 1991). Such a background characteristic increases the likelihood that individuals with poor origin health would have lower SEP and poor adult health. Based on previous research, health selection concerns may be more acute for specific SEP and health outcome measures, particularly educational attainment and mental health (Anderson 2018). Addressing health selection methodologically by accounting for individuals' prior health may explain why past research indicates contradictory evidence on the relative importance of origin and destination SEP and the effects, be they positive, negative, or neither, of intergenerational social mobility on individuals' health in different research settings.

3 Methods

3.1 Dataset

In this study, we have used data from Waves I and IV of the National Longitudinal Study of Adolescent Health (Add Health), a representative longitudinal survey of adolescents in the United States. Wave I of the panel covered the years 1994–95 and included data on 20,745 adolescents aged 12 to 19. Wave IV, conducted in 2007–2008, is the latest publicly available wave at the time of writing, and consists of 76% of the original sample (15,701) with an average age of 29. We have used the public-use version of Add Health, which includes 6,504 respondents selected randomly from the restricted full sample in Wave I, while Wave IV, due to survey attrition, includes 5,114 individuals. The public-use version is freely available to researchers. The main differences between the public and restricted versions of Add Health arise due to confidentiality concerns. The full version of the dataset includes more personal information about respondents, such as their romantic relationships and DNA-related data. These topics are not of particular relevance to our research. The randomised selection of respondents in the public-use version of Add Health allows us to maintain the representativeness of these US adolescents in our study.

3.2 Health outcomes and adolescent health status

One of the goals of using the Add Health dataset in this study has been to identify and simultaneously analyse several variables that capture different dimensions of individuals' health. These three areas are of particular interest: physical health, mental health, and self-rated health. Simultaneously, an essential part of our research design has been to identify and account for health selection effects by explicitly controlling for individuals' adolescent health (Wave I) for each of the selected health outcomes measures. These considerations narrowed the choice of outcome variables to only those measures for which the data in both Waves I and IV are available. Another constraint is related to the Add Health sample's age composition at Wave IV, consisting of relatively young and healthy individuals, making it challenging to analyse health outcomes with a low variation level. Considering these constraints, we have been able to identify three relevant health outcome indicators: BMI as a measure of physical health (Kamel 2001); Center for Epidemiological Studies Depression Scale (CES-D scale) as a measure for mental health (Radloff 1977); and self-rated health as a measure of self-perceived health status (Bailis et al. 2003).

We first calculated individuals' BMI scores using body weight and height information and then created a binary obesity indicator equal to 1 if BMI is 30 or higher. The second measure, the CES-D scale captures the mental wellbeing of the individuals. The scale is based on questions aiming to detect depressive symptoms, such as poor appetite or sleep problems. It is equal to 0 if the respondent reports no depressive symptoms and increases as the number and episodes of symptoms increase. The main advantage of using this measure comes from its sensitivity and its potential to act as an early indicator of mental and related health problems. The third measure, self-rated health, is equal to 1 if the respondent reports their health as very good or excellent, 0 otherwise. The main benefits of using this measure are its simplicity and the possibility to compare results with other studies (Iveson and Deary 2017; Pascual and Cantarero 2009). This health indicator is associated

with numerous health outcomes, including mortality and allostatic load (Boardman 2006; Lorem et al. 2020; Vie et al. 2014).

Based on the evidence from previous research, we know that the health measures described are manifested differently depending on individuals' sociodemographic, socioeconomic and spatial characteristics. For instance, significant racial disparities in the risk of being obese are already present in early childhood (Williams 1995; Zilanawala et al. 2015). Women generally have more complaints of depression than men (Brown et al. 2016; Van de Velde et al. 2010). Characteristics of the neighbourhoods where individuals reside are significantly associated with self-rated health (Giatti et al. 2010). Therefore, it is important to account for individual-level and contextual factors when investigating the relative importance of origin and destination SEP and the potential effect of social mobility on the measures of health being considered.

Additionally, Add Health includes information on the health outcome measures at Wave I which match outcome measures used at Wave IV. One of our study's contributions is to account for individuals' adolescent health status to better understand the role of the origin and destination positions and the health effects of social mobility, because adolescent health might affect later-life health and SEP attainment. Not accounting for adolescent health status could result in biased estimates. An advantage of Add Health is that the selected health outcomes are observed across different waves. To account for health selection for all three health outcomes in multivariable models, we also control for the same health outcomes but derived from Add Health Wave I. Table 1 presents descriptive statistics for the health measures used in our study. Due to list-wise deletion of observations with missing information, our analytical sample in the main analysis consists of 3,551 observations.

3.3 Social origin and destination

To generate individuals' social origin variables, we have used information on parental characteristics reported by parents at Wave I, while individuals' social destination variables have been constructed from their SEP at Wave IV. Individuals with different destination positions, when compared to their origin, are considered socially mobile. We selected three different measures of SEP for individuals and their parents: (1) educational attainment; (2) occupational status; and (3) household income. Education is the first SEP measure that we consider; it is also causally linked to individuals' health (Zajacova and Lawrence 2018).

Table 1 Descriptive statistics, health measures

Variable	Mean	SD	Min	Max
Being obese				
Wave I	0.06	0.24	0	1
Wave IV	0.37	0.48	0	1
Reporting good self-rated health				
Wave I	0.69	0.46	0	1
Wave IV	0.59	0.49	0	1
Depressive symptoms				
Wave I	10.26	3.02	0	30
Wave IV	10.44	2.62	2	26

N = 3551

This measure is particularly relevant because at Wave IV the respondents are, on average, 29 years old, and in most instances, they have completed their formal studies (Bernardi and Ballarino 2016). Add Health includes 13 educational categories for respondents and 10 for parents, as there were fewer educational categories for postgraduate level for the earlier generation. Parental education is based on mothers' or fathers' highest educational level (Erikson 1984). We have collapsed the original measures for both individuals and parents into three categories: (1) completed high school or lower; (2) above high school but not completed college; and (3) finished college.

The next measure of SEP, occupational status, is more likely to capture differences related to the level of earnings, quality of work, autonomy and security (Erikson and Goldthorpe 2002). For both parents and respondents, we create occupational variables based on the Nam-Power-Boyd scale score (Nam and Boyd 2004), which is in line with previous studies using the same dataset (Dennison 2018; Ueno et al. 2013). The scale, based on the analysis of United States' census data, is frequently updated to reflect labour market changes. It is a measure of occupational status derived from the median earnings and median educational attainment of a given occupation. Examples of the highest Nam-Power-Boyd scores (90–100) include occupations such as physicians and surgeons, while housekeeping cleaners and dishwashers have the lowest scores (1–6). Occupational attainment in Add Health is represented by variables related to various details of parents and respondents. For individuals, we have used the Standard Occupational Classification codes converted into status scores using the Nam-Power-Boyd scale, which has allowed us to generate tertiles for this continuous occupational status measure. In the case of parents, there are only ten occupational categories given in the dataset. We calculate the average Nam-Power-Boyd scale score for each of these and, as in the case of individuals, create tertiles. The first and the third tertiles represent, respectively, occupations with the lowest and the highest status.

Finally, we consider household income as the third measure of individuals' SEP. Income is a distinct indicator of individuals' socioeconomic gradient, and reflects individuals' underlying differences in productivity, which are not captured by educational attainment or occupational status (Lemieux et al. 2009). We create tertiles based on reported household income for parents and individuals, respectively, in Waves I and IV. We use household income in this study instead of personal income because only household income is available for parents. The main shortcoming of this measure is that it does not necessarily reflect individuals' SEP but might instead show the economic standing of households in which the individuals live (Bee and Rothbaum 2017). Figure 1 shows that the SEP measures considered are correlated with each other, but these associations are not very strong.

3.4 Confounding variables

We adjust results from all estimated models by respondents' age and gender. Also, given the evidence from health inequalities research, we include a set of controls associated with health outcomes in the United States (Braveman et al. 2011)—respondent's race (White, Black, Asian, Other), the type of residential area (rural = 1), and marital status (married = 1). In addition to individual-level factors, we also account for several characteristics of the neighbourhoods where individuals grew up. We control for race composition, rate of poverty, and level of unemployment. All descriptive statistics for the outcome measures and explanatory variables are presented in Table 1A in the supplementary materials.

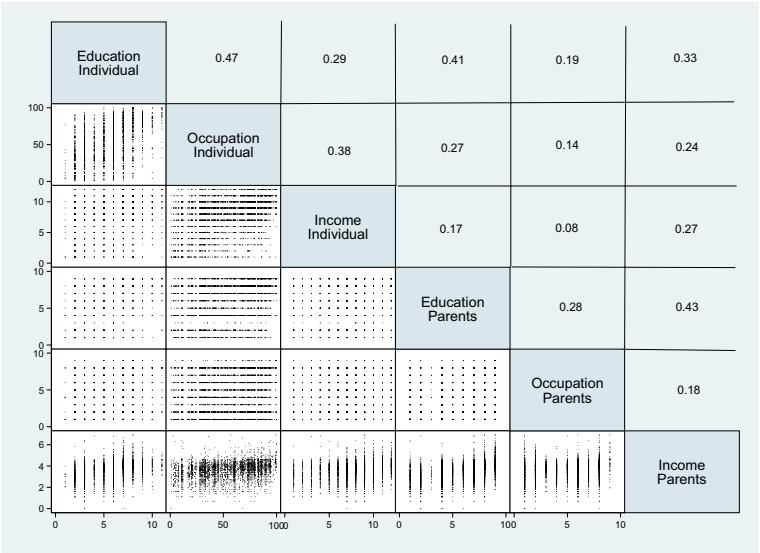


Fig. 1 SEP-related measures, plots and correlations

3.5 Statistical analysis

This study uses diagonal reference models (DRM) to examine the relationship between three different SEP measures and three different health outcomes. This statistical approach evaluates the relative impact of the origin and destination SEP on the health outcomes considered. DRM is regarded as an appropriate statistical method to disentangle social mobility effects from origin and destination position effects. Several studies have conducted evaluations of this statistical tool, showing its advantages over conventional regression approaches in modelling social origin, destination, and mobility effects (Houle and Martin 2011; Sobel 1981; van der Waal et al. 2017). The main feature of DRM is that immobile individuals' outcomes, health measures in our case, are estimated by the weighted mean values of health outcomes for those located in the diagonal cells in the two-dimensional three by three mobility table (since all of our SEP measures have three levels). DRM estimates a weight parameter, representing the relative importance of parental SEP, taking values between 0 and 1. Values above 0.5 for the origin weight parameter indicate that parental position matters more than an individual's position and has greater relative importance in determining individual health outcomes. Formally, our baseline models are constructed as follows:

$$Y_{ij} = w * u_{ii} + (1 - w) * u_{jj} + \beta_k \text{Confounders}_k \quad (1)$$

$$Y_{ij} = w * u_{ii} + (1 - w) + u_{jj} * \beta_k \text{Extended confounders}_k \quad (2)$$

where *i* represents parents and *j* respondents. Y*ij* is the estimated average value of a health outcome. This value is predicted by weighted mean values of health (u_{ii} and u_{jj}) for immobile respondents. Origin weight is represented by *w* (the relative influence of parental characteristics), and *1-w* represents destination weight (the relative impact of individuals' characteristics).

Confounders in Eq. 1 include age and gender, while Eq. 2 introduces an extended set of confounders that includes race, marital status, rural settlement indicator, and neighbourhood race, employment and poverty estimates.

After assessing the role of parental and individuals' own SEP positions on physical, mental and self-rated health, we use DRM to detect any social mobility effects on health. In this approach, we use diagonal intercepts and weight parameters to obtain a cell-specific intercept for each off-diagonal cell (for those who experience mobility in downward or upward direction) in the mobility table. With all off-diagonal cells predicted, DRM design makes it possible to estimate the effect of social mobility, via including upward and downward mobility dummies in models, given the value of health outcome measures determined by the origin and destination SEP. DRM coefficients are interpreted as in conventional regression models, and mobility effects, described in the following paragraph, are estimated in reference to immobile individuals. Even if no significant mobility effects are identified, these mobility variables still play an essential role in obtaining unbiased DRM estimates.

For this reason, we introduce two dummy variables for upward or downward mobility which represent mobility effects in our models. Based on previous studies, we expect that the choice of SEP and health measures, as well as controls, may affect the extent to which origin and destination positions impact individuals' health outcomes (Dennison 2018; Murray et al. 2011; Präg and Richards 2019). Equation (3) formally introduces binary mobility variables to capture upward and downward mobility effects.

$$\mathrm{Y_{ij}} = \mathrm{w} * \mathrm{u_{ii}} + (1 - \mathrm{w}) * \mathrm{u_{jj}} + \beta_{\mathrm{k}}\mathrm{Extended\ confounders_k} + \beta_{\mathrm{m}}\mathrm{Up_m} + \beta_{\mathrm{m}}\mathrm{Down_m} \quad (3)$$

Finally, we carefully address health selection by examining how the introduction of Wave I adolescent health variables affects the main estimates, particularly the origin weight and social mobility parameters. We test the extent to which respondents' adolescent health affects the relative importance of origin weight and individuals' mobility on health by fitting interaction terms into the DRMs. Equation (4) introduces the respective Wave I health controls to account for early health conditions that may affect individuals' mobility, the relative importance of origin SEP and Wave IV health outcomes. We have used the following controls respectively: obesity (1 = obese, 0 otherwise), self-rated health (1 = excellent or very good health, 0 otherwise) and a mental health score based on the Center for Epidemiological Studies Depression Scale (CES-D scale). These health controls are an exact match between Waves I and IV. To test if adolescent health moderates the effect of social mobility, in Eq. (4) we also interact Wave I health with social mobility parameters.

$$\begin{aligned}\mathrm{Y_{ij}} = {} & \mathrm{w} * \mathrm{u_{ii}} + (1 - \mathrm{w}) * \mathrm{u_{jj}} + \beta_{k}\mathrm{Extended\ confounders_k} + \beta_{\mathrm{m}}\mathrm{Up_m} + \beta_{\mathrm{m}}\mathrm{Down_m} \\ & + \beta_{\mathrm{k}}\mathrm{Adolescent\ health_k} + \beta_{\mathrm{mk}}\mathrm{Mobility} * \mathrm{Adolescent\ health_k}\end{aligned} \quad (4)$$

With these specifications, we aim to identify differences across models with different SEP and health measures. DRM estimates have been obtained using the "DRM" module in the Stata 16 statistical software (Kaiser 2018).

4 Results

4.1 Educational attainment

Table 2 shows the results from six diagonal reference models with education as the SEP variable considered. In line with the previous research, age is negatively associated with physical health outcomes, while young males have better health than young females (Clarke et al. 2009). We observe a strong social gradient for all three health outcomes: a higher education level is associated with better health among immobile individuals. The origin and destination weights in Models 1–6 indicate that for all considered health outcomes, adulthood position is relatively more important than parental position. For instance, in Model 1 the origin weight is 0.28 (CI 0.10, 0.45), while the destination weight is 0.72 (CI 0.55, 0.90). This relative scale for weight parameters is consistent across models and changes only slightly when additional confounders are introduced in Models 2, 4, and 6. In the latter DRMs, we see that black individuals have consistently worse health outcomes. Married respondents are more likely to be obese, but they still evaluate their general health more positively than individuals with other marital status.

Models 2, 4, and 6 also include the characteristics of neighbourhoods where individuals lived at the time of Wave I. We do not find that neighbourhood racial composition is related to the health outcomes being considered. Still, individuals living in low poverty areas have a lower risk of obesity and better self-rated health. Higher levels of unemployment in neighbourhoods are also associated with a higher likelihood of being obese.

4.2 Occupational status

Table 3 presents the DRM results for occupational status attainment. For the immobile, occupational attainment plays a similar role as education by demonstrating an evident social gradient. This effect is particularly noticeable for self-rated health. Immobile individuals with the top occupational status report much higher overall health (0.34 CI 0.27, 0.41) than those in the lowest occupational category (-0.28 CI -0.35, -0.21). We observe a difference between educational and occupational mobility in mental health and the highest status immobile group. The coefficient is much closer to 0 and statistically insignificant for occupational attainment than for educational attainment. The origin weights for occupational status attainment are greater than for educational attainment in Table 2. This result also means that the differences between the effect of parental and an individual's own SEP on health outcomes are less noticeable.

Further, in contrast to educational attainment results, we have observed noticeable increases in the relative importance of the destination weight after adding more confounders in Models 2, 4, and 6. These increases are most pronounced for the CES-D scale and, to a lesser extent, for obesity. One implication of these findings is that having the extensive set of confounders in the DRMs, particularly for mental health, seems to be important for obtaining more precise origin–destination weight estimates.

4.3 Income attainment and comparing weights across SEP and health outcome measures

Table 4 presents the DRM results for income attainment. As in Tables 2 and 3, we observe a comparable health gradient for immobile individuals. However, the comparison between

Table 2 Educational attainment and health outcomes

	Being obese		Reporting good self-rated health		Depressive symptoms	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.04	0.08	0.60*	0.69*	11.91***	11.82***
	[−0.18,0.26]	[−0.15,0.31]	[0.01,1.19]	[0.07,1.31]	[10.7,13.1]	[10.6,13.1]
Educationally immobile						
Primary	0.05***	0.03*	−0.37***	−0.34***	0.25***	0.22**
	[0.03,0.08]	[0.01,0.06]	[−0.43,−0.30]	[−0.41,−0.28]	[0.11,0.38]	[0.08,0.36]
Secondary	0.05***	0.05***	−0.14***	−0.14***	0.12	0.08
	[0.03,0.07]	[0.02,0.07]	[−0.20,−0.08]	[−0.20,−0.08]	[−0.03,0.26]	[−0.06,0.23]
Tertiary	−0.10***	−0.08***	0.51***	0.48***	−0.36***	−0.31***
	[−0.12,−0.08]	[−0.10,−0.05]	[0.44,0.57]	[0.42,0.55]	[−0.49,−0.24]	[−0.44,−0.17]
Weight parameters						
Origin	0.28**	0.24*	0.24***	0.22***	0.29	0.23
	[0.10,0.45]	[0.01,0.48]	[0.15,0.33]	[0.12,0.32]	[−0.00,0.57]	[−0.12,0.59]
Destination	0.72***	0.76***	0.76***	0.78***	0.71***	0.77***
	[0.55,0.90]	[0.52,0.99]	[0.67,0.85]	[0.68,0.88]	[0.43,1.00]	[0.41,1.12]
Socio-demographic controls						
Age	0.01**	0.01**	−0.02	−0.02*	−0.04	−0.04*
	[0.00,0.02]	[0.00,0.02]	[−0.04,0.00]	[−0.04,−0.00]	[−0.08,0.00]	[−0.09,−0.00]
Gender (ref: female)	−0.04**	−0.03*	0.16***	0.17***	−0.66***	−0.64***
	[−0.07,−0.02]	[−0.06,−0.00]	[0.09,0.24]	[0.09,0.24]	[−0.81,−0.51]	[−0.80,−0.49]
Additional confounders						
Race (ref. white)						
Black	–	0.08***	–	−0.18**	–	0.40***
		[0.04,0.12]		[−0.29,−0.06]		[0.17,0.63]
Asian	–	−0.06	–	−0.50***	–	−0.09
		[−0.15,0.02]		[−0.73,−0.27]		[−0.55,0.38]

Table 2 (continued)

	Being obese		Reporting good self-rated health		Depressive symptoms	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Other	–	0.09**	–	−0.10	–	0.14
		[0.02,0.15]		[−0.27,0.07]		[−0.20,0.49]
Married (ref. unmarried)	–	0.04*	–	0.11**	–	0.01
		[0.01,0.06]		[0.03,0.19]		[−0.14,0.17]
Rural settlement	–	0.00	–	−0.00	–	0.09
		[−0.03,0.04]		[−0.09,0.08]		[−0.08,0.27]
Neighbourhoods characteristics						
Black (ref. White)	–	−0.03	–	0.10	–	0.03
		[−0.08,0.02]		[−0.04,0.24]		[−0.25,0.32]
Other race	–	−0.01	–	−0.08	–	−0.21
		[−0.09,0.08]		[−0.31,0.14]		[−0.67,0.25]
Low poverty (ref. high)	–	−0.08***	–	0.17**	–	0.00
		[−0.12,−0.04]		[0.06,0.29]		[−0.24,0.24]
Medium poverty	–	−0.03	–	0.03	–	0.00
		[−0.07,0.02]		[−0.08,0.15]		[−0.24,0.25]
Medium unemployment (ref. low)	–	0.04*	–	−0.04	–	0.09
		[0.00,0.07]		[−0.13,0.06]		[−0.10,0.27]
High unemployment	–	0.05*	–	−0.10	–	0.22
		[0.00,0.09]		[−0.21,0.01]		[−0.01,0.45]
AIC	6745.34	6476.95	6511.86	6274.54	23,844.54	23,140.15
BIC	6790.85	6593.50	6550.96	6384.85	23,890.14	23,256.92
Number of observations	3551	3551	3551	3551	3551	3551

95% confidence intervals in brackets

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

different intergenerational mobility types suggests that socially immobile individuals in the top income group experience better mental health than individuals in the top educational category. Model 1, in which obesity is the outcome variable, and only the age and gender controls are included, is the only model in which the origin weight is greater than the destination weight. However, this difference diminishes and the origin and destination weights become roughly equal after additional confounders are introduced in Model 2. Models 3–6 provide results which are more in line with the estimates from Tables 2 and 3. For both health outcomes (general self-rated health and depressive symptoms), the destination position appears to be more critical. The introduction of the extended set of confounders has a similar effect on weights in all models, resulting in increases from 0.06 to 0.07 in the relative importance of the destination weights.

Based on the results presented in Tables 2–4, we conclude that the choice of SEP measure has a noticeable effect on the origin and destination weight in obesity outcomes. It also results in variation (from 0.56 to 0.78) in the case of self-assessed physical health. The consequences of using different SEP indicators are also visible in the case of models with mental health outcome. When SEP is based on educational attainment, we find that individuals' characteristics matter more. The destination weight is equal to 0.77, a much higher estimate than income-based SEP, for which the destination weight is equal to 0.59.

4.4 Mobility trajectories and health outcomes

In the preceding sections, we have described social gradient, and origin and destination weights, while in Fig. 2 we show Sankey diagrams for intergenerational mobility trajectories across all SEP and health outcome measures that have been considered. Each column and row represent, respectively, different health and SEP measures. For example, diagrams in the first row show educational attainment and obesity, self-rated health, and CES-D outcomes. The width of each flow shows the relative size of each mobility group. Most individuals stayed in the same SEP as their parents. However, we also observe some exceptions. For example, the top-left diagram shows that more individuals moved up by one step from the lowest educational attainment compared to immobile groups. In line with the results in the previous section, those in the highest SEP have the lowest obesity rates, the highest levels of self-rated health and the lowest CES-D scores (darker colours). In general, we observe better health outcomes for immobile individuals in the highest SEP. Upwardly mobile individuals enjoy better health than those staying in the same SEP. Downwardly mobile individuals have noticeably lower health outcomes than immobile individuals except for the obesity—educational attainment (mid SEP), and for CES-D—income attainment (high SEP) combinations. Although these Sankey diagrams are informative, they do not account for confounding variables and do not allow differentiation of origin and destination effects from mobility effects. For the latter task, we must revert to the DRM approach.

4.5 Are there social mobility effects on health?

This section tests for any residual social mobility effect after accounting for origin–destination positions and confounders in multivariable settings for all SEP and health outcome measures. The results after introducing downward and upward mobility parameters in Table 5 suggest no significant mobility effects. However, we find evidence that adding social mobility variables results in changes in the relative importance of the

Table 3 Occupational status attainment and health outcomes

	Being obese		Reporting good self-rated health		Depressive symptoms	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	−0.02	0.02	0.88**	0.90**	11.60***	11.54***
	[−0.24,0.21]	[−0.21,0.26]	[0.29,1.48]	[0.28,1.53]	[10.36,12.83]	[10.26,12.82]
Occupationally immobile						
Lowest status	0.06***	0.03*	−0.33***	−0.28***	0.33***	0.24**
	[0.03,0.08]	[0.01,0.06]	[−0.40,−0.26]	[−0.35,−0.21]	[0.19,0.48]	[0.09,0.39]
Intermediate status	0.02	0.03*	−0.06	−0.06	−0.14	−0.12
	[−0.01,0.05]	[0.00,0.05]	[−0.13,0.01]	[−0.14,0.01]	[−0.29,0.01]	[−0.26,0.02]
Highest status	−0.08***	−0.06***	0.39***	0.34***	−0.19**	−0.12
	[−0.10,−0.05]	[−0.08,−0.03]	[0.32,0.45]	[0.27,0.41]	[−0.33,−0.06]	[−0.25,0.01]
Weight parameters						
Origin	0.43***	0.32*	0.48***	0.44***	0.41**	0.26
	[0.24,0.63]	[0.05,0.59]	[0.38,0.58]	[0.33,0.56]	[0.15,0.66]	[−0.12,0.64]
Destination	0.57***	0.68***	0.52***	0.56***	0.59***	0.74***
	[0.37,0.76]	[0.41,0.95]	[0.42,0.62]	[0.44,0.67]	[0.34,0.85]	[0.36,1.12]
Socio-demographic controls						
Age	0.01***	0.01**	−0.03*	−0.03**	−0.03	−0.03
	[0.01,0.02]	[0.00,0.02]	[−0.05,−0.01]	[−0.05,−0.01]	[−0.07,0.01]	[−0.08,0.01]
Gender (ref: female)	−0.04**	−0.03	0.11**	0.12**	−0.61***	−0.59***
	[−0.07,−0.01]	[−0.06,0.00]	[0.04,0.19]	[0.04,0.19]	[−0.76,−0.46]	[−0.75,−0.44]
Additional confounders						
Race (ref. white)						
Black	–	0.08***	–	−0.17**	–	0.41***
		[0.04,0.13]		[−0.28,−0.05]		[0.17,0.65]
Asian	–	−0.07	–	−0.38**	–	−0.16
		[−0.16,0.02]		[−0.61,−0.15]		[−0.64,0.32]

Table 3 (continued)

	Being obese		Reporting good self-rated health		Depressive symptoms	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Other	–	0.09**	–	−0.16	–	0.21
		[0.03,0.15]		[−0.33,0.01]		[−0.14,0.57]
Married (ref. unmarried)	–	0.04**	–	0.10*	–	0.01
		[0.01,0.07]		[0.02,0.17]		[−0.15,0.17]
Rural settlement	–	0.00	–	0.02	–	0.10
		[−0.03,0.03]		[−0.07,0.10]		[−0.08,0.27]
Neighbourhoods characteristics						
Black (ref. White)	–	−0.03	–	0.12	–	−0.01
		[−0.08,0.03]		[−0.02,0.26]		[−0.31,0.28]
Other race	–	0.00	–	−0.05	–	−0.12
		[−0.09,0.09]		[−0.28,0.19]		[−0.60,0.35]
Low poverty (ref. high)	–	−0.09***	–	0.22***	–	−0.04
		[−0.13,−0.05]		[0.10,0.34]		[−0.28,0.20]
Medium poverty	–	−0.04	–	0.05	–	0.04
		[−0.08,0.01]		[−0.07,0.17]		[−0.21,0.29]
Medium unemployment (ref. low)	–	0.04*	–	−0.07	–	0.10
		[0.00,0.07]		[−0.16,0.03]		[−0.09,0.29]
High unemployment	–	0.05*	–	−0.14*	–	0.23
		[0.01,0.09]		[−0.26,−0.03]		[−0.01,0.47]
AIC	6486.64	6232.91	6357.54	6134.37	22,801.70	22,197.10
BIC	6531.84	6348.70	6396.37	6243.96	22,846.99	22,313.13
Number of observations	3551	3551	3551	3551	3551	3551

95% confidence intervals in brackets

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

origin and destination weights in selected models. The first three models present DRM output for educational attainment. After introducing the mobility dummies, we observe small decreases in the destination weights for obesity and physical health. In mental health model, this same introduction results in a reduction in the destination weight parameter from 0.71 to 0.36. This is the only SEP measure and health outcome combination for which we observe such a result. Therefore, this change should be interpreted with caution. It is possible that weights are estimated less reliably as the inclusion of mobility dummies imposes an additional restriction to the model. This finding cannot be explained by the choice of SEP or health measures alone, but rather by the specific combination of educational attainment and mental health. The latter finding holds if testing alternative social mobility measures, such as continuous and short/long-range mobility dummies (Table 3A in the supplementary materials). The remaining mental health models with mobility parameters included, in which SEP is derived from occupational status or income attainment (Models 6 and 9), produce estimates which suggest that, in line with our previous estimates, adulthood SEP is of greater importance for mental health.

In the case of SEP based on occupational attainment, the introduction of mobility dummies results in minor changes in the weight parameters (Models 4–6). For income-based SEP, adding mobility leads to more pronounced differences for obesity and mental health outcomes, with the destination weights increasing respectively by 0.11 and 0.16 points (Models 7 and 9).

4.6 The role of adolescent health and its interactions with social mobility

In the next part of our empirical analysis, we present results which account for potential health selection effects. We expect that adolescent health may affect the relevant attainment/mobility and health outcomes. For example, individuals reporting poor health at Wave I may be less likely to go to college. An adolescent health condition may be associated with more costs or perceived problems that decrease individuals' propensity to continue education beyond the secondary level. The models in Table 6 include adolescent health and its interactions with mobility parameters. In all models, adolescent health is an important predictor of future health. Obesity appears to be the most stable outcome in terms of the relative importance of adulthood SEP (Models 1, 4 and 7). For all three SEP measures, destination weight has a virtually identical value of 0.70. However, accounting for adolescent health seems to be particularly important for obtaining these approximately equal weights.

For the second health outcome, self-rated health, the destination weight is differently affected depending on the choice of SEP measure. For income, it decreases slightly in Model 8, after introducing adolescent health measures, to the level observed in the base model (Model 3 in Table 4). In the case of educational and occupational SEP, the destination weight does not change noticeably. Finally, accounting for adolescent health in the CES-D Models 3, 6 and 9, results in small increases in the destination weight for occupational and income-based SEP. For SEP calculated from educational attainment, we observe a further decrease in the destination weight. In general, it can be observed that accounting for Wave I health is crucial as both the coefficients of the immobile SEP groups and weights change. Arguable, to some extent these changes may be due to the health selection problem discussed above.

Additionally, in the same table, we test if individuals' adolescent health changes the relationship between social mobility and later-life health through interacting adolescent health with mobility parameters. These interaction terms remain insignificant across all models presented in Table 6, suggesting that health selection does not significantly affect the observed association between social mobility and health outcomes. To further examine the role of adolescent health, in particular long lasting health problems, we also examine the impact of any chronic health condition reported at Wave I. The results, presented in the supplements, Table 7A, remain largely unchanged.

4.7 Further analysis

Past research shows that the importance of social origin, destination and mobility parameters may vary depending on individuals' sociodemographic and socioeconomic characteristics. For instance, researchers suggest that social origin is more important for depressive symptoms for women than for men (Gugushvili et al. 2019a). It seems likely that adolescent and adulthood SEP, depending on the choice of attainment measure and health outcomes, has varying consequences for different sociodemographic groups. Individuals' age is an important factor affecting the relative importance of adolescent SEP, based on educational attainment, in determining social wellbeing (Steiber 2019). Individual's race is another important factor linked to heterogeneity in health outcomes and SEP (Farmer and Ferraro 2005; Lorant et al. 2003). Considering these findings, we explore the heterogeneous position and mobility effects on health for individuals' age, gender, and race in the supplementary analysis. We use the model's full specification with Wave I health to examine if the impact of social origin and social mobility on different health outcomes varies by including interaction terms between the origin weight, downward and upward mobility and key variables on age, gender, and race in Tables 5A and 6A. We also check for any significant interactions between adolescent health and origin weight. We find no systemic differences across these key characteristics (Table 5A).

Next, we address the issue of the interdependence of the SEP indicators. Education is linked to occupational attainment and, similarly, education and occupation determine income. For example, the origin weight in income models may be greater as it likely reflects educational and occupational attainment. To address this issue we also account for adulthood educational attainment in the models of occupational attainment. Similarly, for income, we additionally account for adulthood educational and occupational attainment. Results, reported in the supplementary materials, Table 8A, show that education is the main factor affecting individuals' health. In the respective models, the origin weight changes as well. In the case of income based SEP a reduction is observed for self-related health and CES-D health outcomes. Models based on occupation produce more mixed results. Possibly this can be explained, to some extent, by the strong interdependencies between three SEP measures (with correlations of 0.30 to 0.47) which affects the parameters of DRM.

Finally, because in this analysis the number of observations is noticeably reduced, mainly due to the missing household income data in Wave I and the survey attrition in Wave IV, we test the robustness of our finding using an imputed dataset with Multiple Imputation by Chained Equations (MICE) procedure. Table 9A presents these results using the imputed dataset with the sample size of 5,114 individuals. The results directly relate to the models from the main tables (Tables 2, 3 and 4). The main coefficients of interest remain largely unaffected.

Table 4 Income attainment and health outcomes

	Being obese		Reporting good self-rated health		Depressive symptoms	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.00	0.04	1.09**	1.08**	12.21***	12.42***
	[−0.26,0.26]	[−0.23,0.31]	[0.40,1.78]	[0.36,1.80]	[10.81,13.62]	[10.97,13.86]
Income immobile						
Bottom tertile	0.09***	0.06***	−0.38***	−0.33***	0.49***	0.39***
	[0.06,0.12]	[0.03,0.09]	[−0.46,−0.30]	[−0.41,−0.24]	[0.34,0.65]	[0.22,0.56]
Middle tertile	0.03	0.03	−0.00	−0.01	−0.17	−0.14
	[−0.00,0.06]	[−0.00,0.06]	[−0.08,0.08]	[−0.09,0.07]	[−0.34,0.00]	[−0.31,0.03]
Top tertile	−0.12***	−0.09***	0.38***	0.34***	−0.33***	−0.25**
	[−0.15,−0.09]	[−0.12,−0.06]	[0.30,0.46]	[0.25,0.42]	[−0.49,−0.16]	[−0.44,−0.07]
Weight parameters						
Origin	0.58***	0.51***	0.44***	0.37***	0.47***	0.41**
	[0.43,0.72]	[0.31,0.71]	[0.33,0.55]	[0.24,0.51]	[0.26,0.67]	[0.13,0.70]
Destination	0.42***	0.49***	0.56***	0.63***	0.53***	0.59***
	[0.28,0.57]	[0.29,0.69]	[0.45,0.67]	[0.49,0.76]	[0.33,0.74]	[0.30,0.87]
Socio-demographic controls						
Age	0.01**	0.01*	−0.03*	−0.03**	−0.05*	−0.07**
	[0.00,0.02]	[0.00,0.02]	[−0.05,−0.01]	[−0.06,−0.01]	[−0.10,−0.00]	[−0.12,−0.02]
Gender (ref: female)	−0.02	−0.01	0.06	0.06	−0.59***	−0.57***
	[−0.05,0.01]	[−0.04,0.03]	[−0.03,0.14]	[−0.02,0.15]	[−0.76,−0.42]	[−0.74,−0.40]
Additional controls						
Race (ref. white)						
Black	–	0.09***	–	−0.03	–	0.43**
		[0.04,0.14]		[−0.16,0.11]		[0.15,0.70]
Asian	–	−0.11*	–	−0.49***	–	0.21
		[−0.22,−0.01]		[−0.77,−0.22]		[−0.35,0.77]

Table 4 (continued)

	Being obese		Reporting good self-rated health		Depressive symptoms	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Other	–	0.08	–	−0.22*	–	0.02
		[−0.00,0.15]		[−0.43,−0.01]		[−0.41,0.44]
Married (ref. unmarried)	–	0.05**	–	0.04	–	0.13
		[0.02,0.08]		[−0.05,0.13]		[−0.05,0.31]
Rural settlement	–	0.00	–	0.07	–	0.03
		[−0.03,0.04]		[−0.03,0.17]		[−0.16,0.23]
Neighbourhoods characteristics						
Black (ref. White)	–	−0.02	–	−0.00	–	0.08
		[−0.08,0.04]		[−0.17,0.17]		[−0.25,0.42]
Other race	–	0.08	–	0.04	–	−0.19
		[−0.03,0.18]		[−0.24,0.32]		[−0.75,0.38]
Low poverty (ref. high)	–	−0.07**	–	0.19**	–	−0.03
		[−0.12,−0.02]		[0.06,0.33]		[−0.31,0.25]
Medium poverty	–	−0.03	–	0.08	–	0.04
		[−0.08,0.03]		[−0.06,0.22]		[−0.24,0.32]
Medium unemployment (ref. low)	–	0.03	–	−0.09	–	0.09
		[−0.01,0.07]		[−0.19,0.02]		[−0.12,0.30]
High unemployment	–	0.03	–	−0.07	–	0.13
		[−0.02,0.08]		[−0.21,0.06]		[−0.14,0.40]
AIC	4969.82	4809.12	4859.67	4733.57	17,434.94	17,016.19
BIC	5013.19	4920.27	4896.93	4838.77	17,478.40	17,127.55
Number of observations	3551	3551	3551	3551	3551	3551

95% confidence intervals in brackets

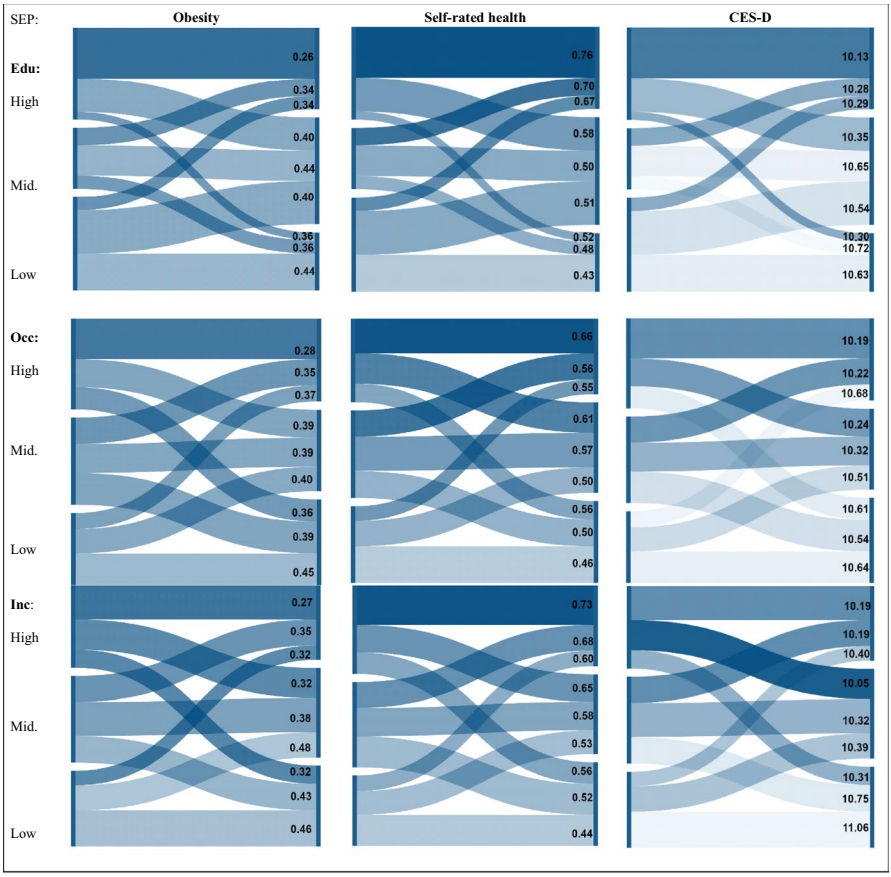
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

5 Discussion

With this study, we contribute to existing scholarship on the relative importance of adolescent and adulthood SEP for individuals' different health outcomes and revisit an old sociological question on the independent effects of social mobility experience on individuals' health and wellbeing. One of the primary motivations for conducting this study was previous contradictory findings in the literature, derived from research with different designs, datasets, sample compositions, analytical methods, and broader country contexts. We have assumed that, since researchers make choices in regards to employing specific SEP measures and health outcomes in their analysis, results might differ between studies precisely due to the methodological decisions described. The role of particular choices is especially relevant, considering that different SEP measures have different associations with health outcomes. In contrast, social determinants of health have varying effects on specific health measures, and similar adolescent and adulthood exposure may affect individual health outcomes more extensively than other health outcomes. Using the high-quality longitudinal study of adolescent health in the United States, we have employed an identical research design but complementary SEP and health outcome measures covering physical, mental, and self-assessed health components.

Using the DRM statistical approach, which is widely acknowledged as the appropriate method to disaggregate social origin, destination, and mobility effects, we have conducted a comprehensive analysis of the three separate SEP measures' associations with three different health outcomes. The results suggest a strong social gradient among socially immobile individuals for all SEP and health outcome measures, especially for self-rated health. After accounting for sociodemographic and socioeconomic confounders, individuals' destination position is more important in determining all health outcomes. The relative weight of destination position ranges between 0.42 and 0.80. When comparing the three SEP measures, we can see that the destination has the most substantial effect on individuals' educational attainment. In turn, household income demonstrates the most potent origin effects, with the impact of occupational status attainment lying somewhere between the impact of educational and income attainment. We have also observed that the inclusion of additional controls results in increases in the destination relative weight. These increases are particularly noticeable for occupational status-based SEP and obesity/mental health outcomes.

In addition to the origin and destination position effects on health, our estimates suggest that a significant share of individuals experience downward and upward social mobility in the United States, even among those who are in their early 30s. We have also shown that the downwardly mobile typically have worse health, while the upwardly mobile have better health than those left behind. Yet, we did not see significant differences between individuals who ended up in the same SEP category. DRM estimates confirm the latter statement, as social mobility parameters turn out to be insignificant. Nevertheless, accounting for social mobility effects leads to a change in origin–destination weight for the combination of mental health and SEP based on educational attainment. This finding is in line with the previous research examining educational attainment, CES-D, and self-rated health and wellbeing (Steiber 2019). However, as this is the only SEP and health outcome combination for which this significant change occurs, caution is advised. The possibility that the origin's weight is estimated less reliably after mobility is accounted for cannot be excluded. Why there are no similar patterns with other SEP measures remains an open question. One other explanation could be that it is too early for mobility effects to kick in in the case of



Note: n= 3551, columns represent different health measures. Rows represent different SEP measures. The average health is reported for each flow. Obesity is binary, where 1=obese, 0 otherwise. Self-rated health is binary, where 1=excellent or very good health, 0 otherwise. CES-D takes values from 0, no depressive symptoms, to 26 the highest number of depressive symptoms. The width of the flows is proportional to the flow quantity.

Fig. 2 Origin and destination SEP, mobility trajectories and health outcomes

occupational status and income attainment for individuals in their late 20s or early 30s. Furthermore, mental health may be the only measure sensitive enough to reflect educational mobility effects in DRM. The unobserved differences in the timing of mobility for different SEP measures may also contribute to this finding.

In general, our results confirm that the choice of health measures contributes to noticeable differences in DRM estimates for various SEP measures. For instance, the relative weights in obesity models remain very stable across all SEP measures and are close to estimates from previous studies (van der Waal et al. 2017). We observe more variation for the self-rated health and CES-D models. Our results confirm the findings from past research indicating more significant destination influence for self-rated health using educational attainment variables (Monden and de Graaf 2013). Also, we identify similarities with past research conducted on a much older age group in the UK with allostatic load used as a health measure (Präg and Richards 2019). At the same time, allostatic load and

Table 5 Three SEP measures with social mobility accounted for

	Educational attainment			Occupational attainment			*Income attainment*		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	Obesity	Self−rated health	CES-D	Obesity	Self-rated health	CES-D	Obesity	Self-rated health	CES-D
Intercept	0.08	0.68*	11.86***	0.02	0.98**	11.51***	0.04	1.08**	12.54***
	[−0.14,0.31]	[0.06,1.30]	[10.60,13.11]	[−0.21,0.26]	[0.35,1.61]	[10.22,12.79]	[−0.23,0.31]	[0.36,1.80]	[11.09,13.99]
Immobile by various SEP									
Bottom tertile	0.03*	−0.34***	0.19**	0.03*	−0.28***	0.24**	0.06***	−0.33***	0.38***
	[0.00,0.05]	[−0.41,−0.27]	[0.05,0.33]	[0.01,0.06]	[−0.35,−0.21]	[0.10,0.39]	[0.03,0.09]	[−0.41,−0.24]	[0.22,0.55]
Middle tertile	0.05***	−0.15***	0.15*	0.03	−0.06	−0.13	0.03	−0.01	−0.14
	[0.02,0.08]	[−0.22,−0.08]	[0.01,0.30]	[−0.00,0.05]	[−0.13,0.02]	[−0.28,0.02]	[−0.00,0.06]	[−0.09,0.07]	[−0.29,0.00]
Top tertile	−0.08***	0.49***	−0.34***	−0.06***	0.34***	−0.12	−0.09***	0.34***	−0.24**
	[−0.10,−0.05]	[0.42,0.55]	[−0.48,−0.21]	[−0.08,−0.03]	[0.27,0.41]	[−0.26,0.02]	[−0.12,−0.06]	[0.25,0.42]	[−0.41,−0.07]
Weight parameters									
Origin	0.32*	0.25*	0.64**	0.33	0.41**	0.27	0.40	0.35	0.25
	[0.02,0.62]	[0.03,0.48]	[0.18,1.11]	[−0.13,0.79]	[0.10,0.72]	[−0.31,0.86]	[−0.05,0.86]	[−0.04,0.74]	[−0.26,0.76]
Destination	0.68***	0.75***	0.36	0.67**	0.59***	0.73*	0.60*	0.65**	0.75**
	[0.38,0.98]	[0.52,0.97]	[−0.11,0.82]	[0.21,1.13]	[0.28,0.90]	[0.14,1.31]	[0.14,1.05]	[0.26,1.04]	[0.24,1.26]
Social mobility									
Upward	−0.02	0.04	−0.19	0.00	−0.10	0.03	0.02	−0.01	−0.09
	[−0.05,0.02]	[−0.09,0.17]	[−0.40,0.02]	[−0.04,0.05]	[−0.25,0.05]	[−0.19,0.26]	[−0.04,0.08]	[−0.20,0.18]	[−0.37,0.19]
Downward	0.00	0.01	0.12	0.00	−0.07	0.04	−0.01	0.01	−0.24
	[−0.04,0.05]	[−0.14,0.16]	[−0.14,0.39]	[−0.04,0.04]	[−0.21,0.08]	[−0.19,0.27]	[−0.07,0.05]	[−0.18,0.20]	[−0.51,0.03]
AIC	6480.25	6278.07	23,141.32	6236.88	6133.78	22,200.89	4812.76	4737.55	17,016.12
BIC	6609.74	6401.35	23,271.07	6365.53	6256.26	22,329.81	4936.26	4855.13	17,139.85
Number of observations	3551	3551	3551	3551	3551	3551	3551	3551	3551

95% confidence intervals in brackets

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

self-rated health measures are not identical (Vie et al. 2014). Together with the choice of mobility indicators and other confounders, all of these characteristics might explain why our estimates differ, especially after the introduction of additional covariates.

To address potentially significant health selection effects, we also derive DRM estimates to account for individuals' adolescent health at Wave I using the identical health measures as those used as outcome variables at Wave IV. We show that, even after controlling for the sociodemographic, socioeconomic, and neighbourhood characteristics, adolescent health is one of the most substantial indications of later-life health. However, our interaction terms between adolescent health and social mobility parameters also suggest that, regardless of individuals' adolescent health status, social mobility experiences per se do not matter for later-life health. Interestingly, accounting for adolescent health provides varying results on origin–destination weights depending on the SEP and health measure combination. For obesity, the destination weight increases in all models. In the case of self-rated health and income-derived SEP, we observe a decrease in destination weights. Mental health models show less variation, with the weight increasing for occupational and income SEP and decreasing for educational attainment SEP. These findings indicate the importance of carefully controlling for covariates and potentially important health selection effects.

Our analysis has some limitations. First, it is likely that the timing for moving up or down in the social hierarchy matters for health outcomes. For instance, the acculturation thesis suggests that the longer individuals spend in their destination position, the more similar they become to those who are originally part of this social group (Blau 1956; Graaf et al. 1995). The inability to precisely pinpoint mobility events due to data limitations, together with the combination of health measures that show varied sensitivity to SEP changes, may have affected our estimates. Second, our analytical sample consists of relatively young individuals, which has two major consequences. We examine outcomes for individuals at a relatively early stage of their career progression. This problem seems to be particularly important in the case of occupational and income attainment. Another consequence is that, for selected health measures observed in the late 20s and early 30s, there may be low levels of poor health observed to provide more meaningful variation to explain given outcomes. These issues can be addressed in the future with the use of the upcoming waves of Add Health. Third, we have had to consider household, rather than individual income as this variable was not available for the parental generation.

6 Conclusion

The main conclusion we can draw from the study presented is that, even if there are no independent mobility effects on health, both origin and destination positions matter, but their relative importance depends on the selection of SEP indicators and health outcome measures, and whether or not individuals' adolescent health is accounted for in statistical models. Future studies on position and mobility effects on health should explicitly outline that their derived findings are largely affected by the methodological choices that researchers make.

Table 6 Three SEP measures with adolescent health accounted for

	Educational attainment			Occupational attainment			*Income attainment*		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	Obesity	Self-rated health	CES-D	Obesity	Self-rated health	CES-D	Obesity	Self-rated health	CES-D
Intercept	0.13	0.31	10.88***	0.06	0.56	10.80***	0.11	0.60	11.67***
	[−0.09,0.35]	[−0.32,0.94]	[9.61,12.14]	[−0.16,0.29]	[−0.09,1.20]	[9.49,12.12]	[−0.16,0.37]	[−0.15,1.34]	[10.20,13.14]
Immobile by various SEP									
Bottom tertile	0.02*	−0.29***	0.16*	0.02	−0.24***	0.22**	0.04**	−0.27***	0.34***
	[0.00,0.05]	[−0.36,−0.22]	[0.02,0.30]	[−0.01,0.04]	[−0.31,−0.17]	[0.07,0.36]	[0.01,0.07]	[−0.35,−0.18]	[0.17,0.51]
Middle tertile	0.04**	−0.14***	0.16*	0.03*	−0.05	−0.10	0.02	−0.01	−0.14
	[0.01,0.06]	[−0.21,−0.07]	[0.01,0.30]	[0.00,0.05]	[−0.12,0.03]	[−0.24,0.05]	[−0.01,0.05]	[−0.09,0.08]	[−0.28,0.01]
Top tertile	−0.06***	0.43***	−0.32***	−0.04***	0.29***	−0.12	−0.07***	0.28***	−0.20*
	[−0.09,−0.04]	[0.36,0.49]	[−0.45,−0.18]	[−0.07,−0.02]	[0.21,0.36]	[−0.26,0.02]	[−0.10,−0.03]	[0.19,0.36]	[−0.38,−0.02]
Weight parameters									
Origin	0.30	0.26*	0.67**	0.30	0.38*	0.20	0.31	0.44	0.22
	[−0.07,0.68]	[0.01,0.51]	[0.20,1.13]	[−0.18,0.78]	[0.02,0.75]	[−0.55,0.95]	[−0.25,0.86]	[−0.05,0.93]	[−0.35,0.79]
Destination	0.70***	0.74***	0.33	0.70**	0.62**	0.80*	0.69*	0.56*	0.78**
	[0.32,1.07]	[0.49,0.99]	[−0.13,0.80]	[0.22,1.18]	[0.25,0.98]	[0.05,1.55]	[0.14,1.25]	[0.07,1.05]	[0.21,1.35]
Social mobility									
Upward	−0.01	0.04	0.32	0.01	−0.07	−0.10	0.02	−0.01	0.09
	[−0.04,0.03]	[−0.13,0.22]	[−0.30,0.93]	[−0.03,0.05]	[−0.27,0.14]	[−0.76,0.56]	[−0.03,0.08]	[−0.25,0.24]	[−0.65,0.83]
Downward	−0.00	−0.02	0.28	0.01	−0.02	−0.28	−0.01	−0.09	−0.25
	[−0.05,0.04]	[−0.22,0.18]	[−0.40,0.96]	[−0.03,0.04]	[−0.22,0.17]	[−0.93,0.36]	[−0.07,0.04]	[−0.34,0.16]	[−0.97,0.47]
Adolescent health	0.56***	0.49***	0.16***	0.57***	0.57***	0.13***	0.56***	0.53***	0.15***
	[0.48,0.64]	[0.37,0.61]	[0.13,0.20]	[0.49,0.66]	[0.44,0.70]	[0.09,0.17]	[0.46,0.66]	[0.39,0.67]	[0.11,0.19]
Interactions									
Upward*adolescent health	−0.03	−0.00	−0.05	−0.05	−0.06	0.01	−0.00	0.02	−0.02
	[−0.16,0.10]	[−0.19,0.18]	[−0.10,0.01]	[−0.18,0.09]	[−0.26,0.14]	[−0.05,0.07]	[−0.16,0.15]	[−0.20,0.25]	[−0.08,0.05]
Downward*adolescent health	0.07	0.04	−0.02	0.03	−0.05	0.02	0.04	0.07	0.00
	[−0.06,0.20]	[−0.17,0.24]	[−0.08,0.05]	[−0.10,0.16]	[−0.24,0.14]	[−0.03,0.08]	[−0.12,0.19]	[−0.15,0.28]	[−0.06,0.07]

Table 6 (continued)

	Educational attainment			Occupational attainment			*Income attainment*		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	Obesity	Self-rated health	CES-D	Obesity	Self-rated health	CES-D	Obesity	Self-rated health	CES-D
AIC	5875.61	6135.30	22,961.79	5647.34	5964.55	22,024.14	4390.93	4600.14	16,881.73
BIC	6023.91	6278.04	23,110.96	5794.67	6106.37	22,172.34	4532.36	4736.27	17,023.98
Number of observations	3551	3551	3551	3551	3551	3551	3551	3551	3551

95% confidence intervals in brackets

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

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Declarations

Conflict of interest The authors have no conflict of interest related to this manuscript.

Ethics approval This study does not require ethical approval as it uses publicly available secondary survey data.

Consent to participate Not applicable.

Consent for publication Not applicable.

Availability of data and material This study uses publicly available dataset.

Code availability STATA code for this study is available from the authors upon request.

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