



All cause and cause specific mortality in 15-24-year-olds in Denmark 2010 to 2022: nationwide study of socioeconomic predictors

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ABSTRACT

OBJECTIVE To assess inequalities in all cause and cause specific mortality in young people and if there are differences across gender and age groups.

DESIGN Nationwide cohort study of socioeconomic predictors.

SETTING Denmark, 1 January 2010 to 31 December 2022

PARTICIPANTS All Danes of ages 15 to 24 years during the study period summing to a total of 9 314 807 person years and 2297 deaths. Participant and parental information were linked to obtain information on socioeconomic background to investigate differences in parents' educational level, employment status, and family's disposable income, using annually updated nationwide registers.

MAIN OUTCOME MEASURES All cause and cause specific mortality including natural deaths (ie, medical conditions and diseases) and unnatural deaths (accidents, suicides, and homicides). Poisson regression was used to calculate incidence rate ratios and 95% confidence intervals (CI).

RESULTS Overall mortality rate was 24.7 (95% CI 23.7 to 25.7) and higher for men (33.2 (31.5 to 34.8)) compared with women (15.8 (14.6 to 16.9)). All cause and cause specific mortality were higher in financially disadvantaged groups compared with more affluent groups, and consistently so for all three measures of socioeconomic position. Results generally reflected a dose dependent

association showing a higher mortality with lower levels of socioeconomic position. For instance, incidence rate ratios of all cause mortality related to parents' education was 2.3 (95% CI 2.0 to 2.7) for elementary level, 1.5 (1.3 to 1.6) for low, and 1.3 (1.1 to 1.4) for medium level as compared with high level. For deaths, incidence rate ratios of elementary education level compared with the most well educated group were 2.2 (1.5 to 3.2) for natural causes, 3.3 (2.5 to 4.4) for accidents, 1.6 (1.2 to 2.2) for suicides, and 3.1 (0.8 to 12) for homicides. Associations were similar in strata of men and women and by age group (15-17 v 18-24 years). Mortality in young men was considerably higher than in young women for all of the causes.

CONCLUSION Young people from disadvantaged backgrounds have a markedly higher mortality from all causes than those from more affluent families. The socioeconomic position of their parents was associated with premature mortality in a dose dependent manner meaning that this effect is not only a concern for marginalised groups. Public health attention should be directed to respond to these inequities by strengthening advocacy for adolescent health, ensuring focus on adolescents in health policies and strategies, using the response to adolescent health as an indicator of equity, and prioritising research into the underlying mechanisms linking socioeconomic position in adolescence and mortality.

WHAT IS ALREADY KNOWN ON THIS TOPIC?

- ⇒ Ample evidence shows that socioeconomic inequality in mortality exists in children and adults: disadvantaged groups die earlier than more affluent groups
- ⇒ Literature on socioeconomic differences in mortality in young people is sparse, outdated, and has shown mixed results regarding the social pattern in deaths due to natural causes such as diseases and medical conditions

WHAT THIS STUDY ADDS

- ⇒ Mortality in young people in Denmark is consistently socially patterned across measures of socioeconomic position and causes of deaths including natural and unnatural deaths caused by accidents, suicides, and homicides
- ⇒ Socioeconomic inequality in mortality in young people in Denmark is present across the range of socioeconomic positions including the middle group, representing the general population, and is thus not limited to a marginalised group

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

- ⇒ Future research should pay attention to the underlying mechanisms that drive socioeconomic health inequalities in young people

Introduction

Socioeconomic inequality in health is widely acknowledged, with disadvantaged groups having shorter lifespans compared with more affluent groups.¹⁻⁴ Research has mainly focused on children and adults and therefore, understanding is limited as to how socioeconomic differences contribute to mortality in young people.⁵ Premature death in young people is a pressing global public health issue because mortality in 15-to 24-year-olds is now higher than in early childhood (ages 1-5 years).⁶ This shift in age patterns is caused by a global decrease in mortality in young people that is relatively smaller compared with that of child mortality, which has been suggested to indicate that health of young people has been given lower priority than health in early childhood.⁷

After the publication of the Black report in 1980⁸ (a report on health inequality published by the

Department of Health and Social Security in the UK) a handful of studies were published suggesting a socio-economic gradient in mortality in young people, yet several aspects remain unclear. Firstly, most studies were conducted over two decades ago and used simplified or outdated measures of socioeconomic position as the sole measure of socioeconomic position, of which these include median family income by census tract,⁹ dichotomous employment status (manual or not manual worker),^{10–12} parental level of health insurance contribution as a proxy for income,¹³ and occupational skills.¹⁴ Overall, these studies did find some trends towards a socioeconomic association in mortality in young people, but the evidence was not clear cut. A study of England and Scotland published in 2017 using nationwide register data supported this overall trend because they found increased mortality rates in 15–24-year-olds living in deprived areas in age stratified analysis.¹⁵ Still, empirical evidence with a focus on the youth population is scarce, and re-examination of the socioeconomic association with mortality is needed using newer and more detailed measures. Secondly, these studies suggest that socioeconomic inequality associated with mortality in young people primarily applies to accidents,^{9–11 14} while evidence on cause specific deaths is scarce. Thirdly, socioeconomic differences in risk of premature death is suggested to be affected by gender^{10 12 13} and age.^{9 10 12 13 16} For example, studies have indicated that the association between social background and mortality is higher in young men than in young women.¹⁰ The affect of age might be because of changing perception of importance of parents' socioeconomic position, during the transition from late teenage years to young adulthood.

In contrast to mortality in children and adults, most deaths in young people in high income countries are attributable to unnatural causes (70% in men and 50% in women between ages 10–24 years).¹⁷ Injuries such as traffic accidents and self-harm are causes that have the potential to be prevented and understanding of the unique circumstances surrounding death in young people is important to reduce health inequities¹⁸ and to prioritise youth health.⁷

In this study, we used comprehensive nationwide registers that provided complete information on deaths and socioeconomic measures in Denmark, allowing us to explore the associations between socioeconomic background and mortality in young people. We hypothesised that parents' socioeconomic position, as measured by parents' educational level, employment status, and income, is associated with all cause and cause specific mortality in 15–24-year-olds. We also investigated whether these associations differed based on the manner of death, such as those by natural causes or from accidents, suicide, and homicide.

Methods

Study population

We conducted a nationwide study including all individuals in Denmark between 15 and 24 years from 2010 to 2022. Any individual within that age range was included for as long as they met the age restriction criteria. All data were updated annually. As such, the study population constituted an open cohort study, in which we included individuals as they either turned 15 years or excluded them once they turned 25. The study period of 13 years (1 January 2010 through 31 December 2022) included an average of 716 523 individuals per year, corresponding to a total of 9 314 807 person years.

Information about any person who is a permanent resident in Denmark is included in the Danish Civil Registration System,¹⁹ which contains basic information such as legal gender, date of birth, immigration, nationality, and parents' identification number. Data from this register served as the backbone for the current study. We used the personal identifying number to link unique information from different national registers, to obtain information about deaths, parents' socioeconomic status, and ethnic group.

Mortality data

Detailed information about deaths was acquired from the register of causes of death.²⁰ In Denmark, when an individual dies, a doctor performs a post-mortem examination and adds cause of death to the death certificate. The certificate has information about the manner and cause of death, that is whether the death was from natural causes such as a medical condition or from unnatural such as external factors comprising accidents, suicides, and homicides. In cases where the death is deemed unnatural or unexpected, an in-depth post-mortem examination is done by a physician from the Danish agency for patient safety in collaboration with the police. Based on this examination, a decision can be made to proceed with an autopsy, aiming to determine the precise manner and underlying cause of death. The underlying cause of death is defined as the disease or injury that initiated the series of events that led to the person's death. The unknown category for the manner of death is only used when an autopsy has been conducted and proved inconclusive. In all cases, death certificates are filled in and the information is transferred to the register of causes of death.²⁰ The Danish health data authority manually reviews details regarding all unnatural deaths to ensure the accuracy of the recorded information. Data for all cause mortality were available for 2010–22 and obtained from the Danish civil registration system.¹⁹ Information about cause specific deaths as obtained from the register of causes of death was available from 2010 to 2021 and not 2022 because the registration

Table 1 | Deaths per person year, mortality rates, and 95% confidence intervals (CIs) per 100 000 population by manner of death in 15-24-year-olds

Type of death	Total		Men		Women	
	Deaths/person year	Rate (95% CI)	Deaths/person year	Rate (95% CI)	Deaths/person year	Rate (95% CI)
All deaths	2297/9 314 807	24.7 (23.7 to 25.7)	1580/4 763 538	33.2 (31.5 to 34.8)	717/4 551 269	15.8 (14.6 to 16.9)
Natural death	829/8 602 441	9.6 (9.0 to 10.3)	487/4 399 573	11.1 (10.1 to 12.1)	342/4 202 868	8.1 (7.3 to 9.0)
Accident	732/8 602 441	8.5 (7.9 to 9.1)	565/4 399 573	12.8 (11.8 to 13.9)	167/4 202 868	4.0 (3.4 to 4.6)
Suicide	447/8 602 441	5.2 (4.7 to 5.7)	319/4 399 573	7.3 (6.5 to 8.1)	128/4 202 868	3.1 (2.5 to 3.6)
Homicide	78/8 602 441	0.9 (0.7 to 1.1)	67/4 399 573	1.5 (1.2 to 1.9)	11/4 202 868	0.3 (0.1 to 0.4)

All cause mortality includes all deaths from 2010-22. Cause-specific mortality includes all deaths from 2010-21. A total of 34 deaths were due to unknown causes.

process is longer causing some delay in data access.²⁰

Socioeconomic measures

Socioeconomic position was operationalised by three variables: parents' employment status, educational level, and family income. This information was obtained from national registers on employment status (labour force statistics),²¹ highest attained education (population's education register),²² and family disposable income (income statistics register).²³ Employment status was categorised into three groups: both parents working; one parent working, one receiving benefits; and both parents receiving benefits. Educational level was categorised into four groups, based on the parent who attained the highest educational level: elementary school (10 years mandatory education); low education, covering upper secondary school (high school (three years) and vocational education (four years including works experience)); medium education covering higher education following upper secondary school (Academy Profession degree (two years), Bachelor's degree (three years), and Professional Bachelor's degree (three to four years)); and high education (Master's degree following bachelor's degree (two years) and PhD following Master's degree (three years)). Family income, as derived from the Income

Statistical Register,²³ was operationalised into quintiles and also used continuously.

Other covariates

Gender was defined as man or woman based on information from the Danish civil registration system.¹⁹ Information about ethnic group was obtained from statistics Denmark²⁴ and was defined as Danish origin or first or second generation immigrant.

Statistical analysis

We used Stata version 17 for all analysis. The socioeconomic variables had missing information for parents' employment status (4.8%), parents' education (6.1%), parents' disposable income (4.8%), and immigration status (0.1%). Information about age and gender was complete. Given the relatively low number of deaths from a statistical standpoint, we opted to use multiple imputation by chained equations²⁵ (Stata procedure mi impute chained, 10 imputations) to address missing values and retain the full sample. The model included age, gender, immigration status, and socioeconomic measure (parents' employment status, educational level, or income). Socioeconomic data were updated yearly, at the beginning at the year. The procedure was run in strata of calendar year. Poisson regression was used to calculate incidence rates, incidence rate ratios, and 95% confidence intervals (95% CIs) for all cause death and cause specific death. In 34 cases, the manner of death was recorded as unknown therefore these people could not be included in analysis of cause specific mortality. We estimated for each imputation separately and then combined using Rubin's rule.²⁶ Models were adjusted for gender, age, immigration status, and calendar year. Furthermore, we adjusted standard errors allowing for clustering of data by year to consider the precondition of the Poisson analysis that observations were independent. Restricted cubic splines with income as a continuous variable were modelled to illustrate the shape of the risk curve over the full spectrum of income allowing for non-linearity.^{27 28} We used four knots

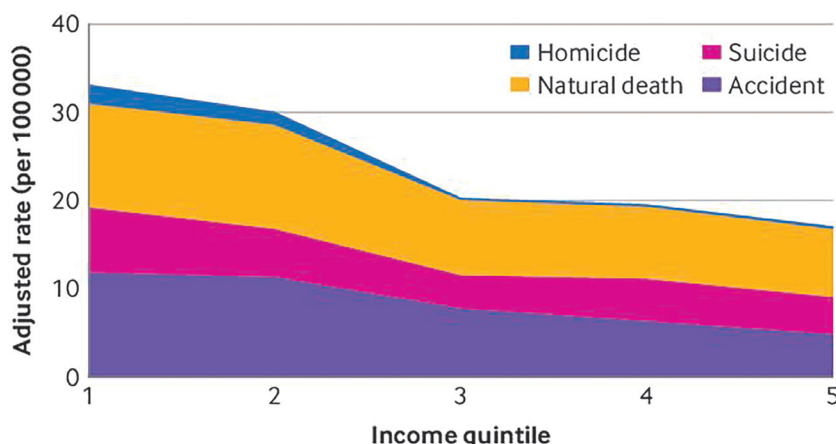


Figure 1 | Age adjusted mortality rate in 15-24-year-olds in Denmark from 2010 to 2021 by family income quintile from lowest (1) to highest (5).

set at the fifth, 35th, 65th, and 95th percentile of the income distribution. We tested for a statistical interaction between socioeconomic position and both gender and age group. This test was done by including main effects as well as interaction terms and subsequently testing the combined effect of interaction terms using an F-test.

Patient and public involvement

No patients were directly involved in the study because it is register based.

Results

From 2010 to 2022, 2297 deaths were registered in individuals aged 15-24 years in Denmark, corresponding to a mortality rate of 24.7 (95% CI 23.7 to 25.7) per 100 000 (table 1). Death from natural causes accounted for 40% (n=1040) of all deaths and those from unnatural causes accounted for 60% (n=1257). Unnatural causes consisted of 58% from accidents, 36% from suicide, and 6% from homicide. All cause mortality was more than twice as high for young men (incidence rate 33.2 (95% CI 31.5 to 34.8)) as compared with young women (incidence rate 15.8 (95% CI 14.6 to 16.9)) and rates of natural death, accidents, and homicide were consistently higher in men. Whereas accident was the most frequent manner of death in men, natural death was the most frequent manner of death in women. Suicide constituted a considerable proportion of deaths in both men (20%) and women (18%). Neoplasms (n=240, 29%), other non-communicable disorders (n=204, 26%), and neurological disorders (n=133, 16%) were the most frequent causes of natural death (online supplemental table 1).

A social gradient was shown by a lower absolute number of deaths with each increase in income fifth

(figure 1). The absolute number of deaths was 599 in the lowest income group and reduced by almost half to 286 in the highest income group between 2010 and 2021. Accidents constituted a substantial number of deaths across income groups and lower rates of accidental deaths contributed to the drop in the total number of deaths with higher income (figure 1). Notably, a consistently lower number of natural deaths was also seen across the full spectrum of increasing income.

All cause mortality differed depending on the parents' socioeconomic position in models adjusted for gender, age, immigration status, and calendar year (figure 2). That is, a social gradient was systematically observed for parents' employment status, education, and income. For instance, any reduction in educational level was associated with a continuously higher incidence rate ratio of death from any cause (1.0 (ref) high educational level, 1.3 (95% CI 1.1 to 1.4) medium, 1.5 (1.3 to 1.6) low, and 2.3 (2.0 to 2.7) elementary school). Similar patterns applied for employment status and income so that incidence rate ratios were higher for each parent not working and for each lower income level.

Associations between all three measures of parents' socioeconomic position and all cause mortality appeared similar in young men and young women (figure 3), in 15-17 year-olds, and in 18-24 year-olds (figure 4). This impression was consolidated by multiplicative tests for interaction that were statistically insignificant.

In adjusted, cause specific regression models, incidence rate ratios of deaths due to natural causes and accidents were consistently higher in the more disadvantaged groups across all three measures of socioeconomic position (figure 5). Incidence rate ratios were consistently higher for each lower in socioeconomic position in a dose dependent pattern across the all employment statuses, educational levels, and incomes. Although the gradient for accidents was steeper compared with natural deaths, a dose dependent pattern in mortality with employment status, educational level, and income was equally consistent. For instance, incidence rate ratios of natural deaths were two fold higher in the lowest educated group (2.2 (95% CI 1.5 to 3.2)) as compared with the most well educated group (1.0 (ref)). Data for deaths due to suicide and homicide appeared to follow a similar social pattern; although, they were less consistent and with greater statistical uncertainty. Nevertheless, incidence rate ratios of suicide and homicide were highest in the most disadvantaged group when comparing the highest and lowest socioeconomic groups. For instance, the incidence rate ratio of suicide was 2.3 (95% CI 1.8 to 3.0) if neither parent worked, 1.6 (1.2 to 2.2) if parents' highest attained education was elementary school, and 2.2 (1.8 to 2.8) if they were in the lowest income quintile. Compared with young women, young

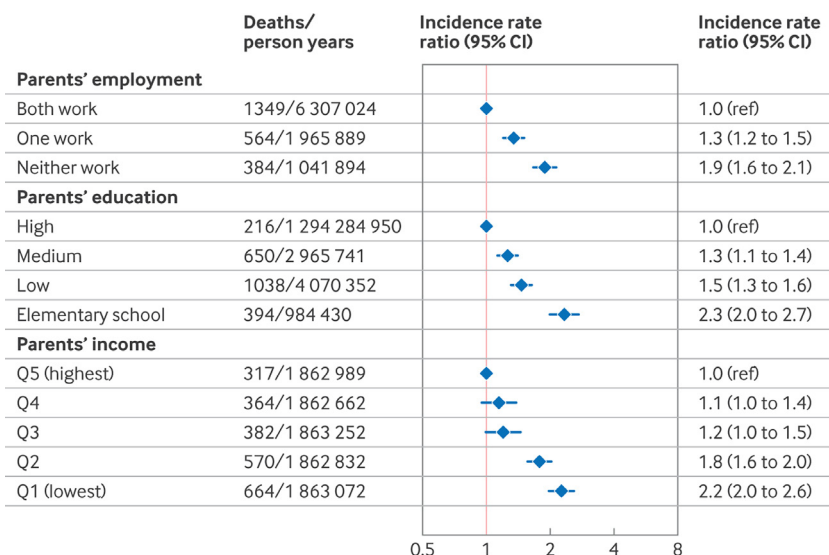


Figure 2 | Deaths per person year, incidence rate ratios, and 95% confidence interval (95% CI) by parents' socioeconomic position in 15-24-year-olds, Denmark 2010-22. Q=quintile

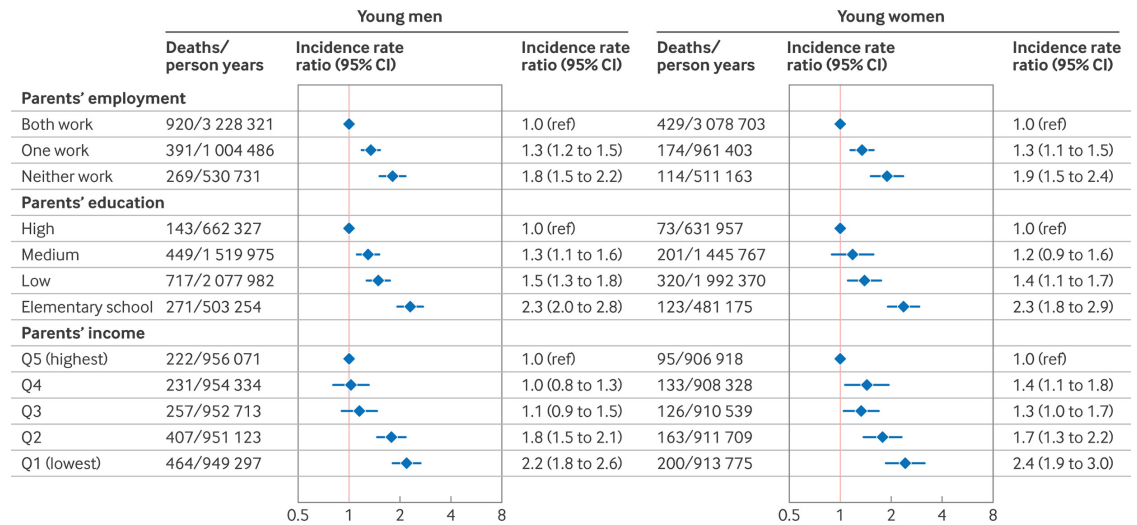


Figure 3 | Deaths per person year, incidence rate ratios, and 95% confidence interval (95% CI) by gender and parents' socioeconomic position in 15-24-year-olds, in Denmark, 2010-22. Q=quintile

men had higher incidence rate ratios of death from natural causes (1.4 (95% CI 1.2 to 1.5), accidents (3.2 (2.7 to 3.8)), suicides (2.4 (1.9 to 3.0)), and homicides (5.8 (2.8 to 12.3)) when socioeconomic position was accounted for. We found no indication of interaction between socioeconomic position and gender or age group for all cause mortality as well as any of manners of death (all P values were >0.05).

Second generation immigrants had higher incidence rate ratios of all cause mortality (1.3 (95% CI 1.1 to 1.6)) in gender and age adjusted models than did participants born in Denmark (online supplemental table 2). Differences according to immigration highly depended on the manner of death. That is, incidence rate ratios of suicide were lower in second generation immigrants (0.39 (95% CI 0.20 to 0.75)) whereas mortality from homicide was more than ten fold higher (12.59 (6.90 to 22.94)). Noticing the broad confidence interval, some of the effect might

possibly be explained by lack of statistical power in this subgroup. Further adjustment for socioeconomic position measured as family income resulted in enlarged differences in mortality from accidents (0.63 (0.43 to 0.94)) and suicides (0.28 (0.15 to 0.51)) in second generation immigrants compared with participants born in Denmark. Whereas, differences in mortality from homicides were reduced (7.23 (3.8 to 13.75)). Consequently, adjustment for socioeconomic position showed that ethnic group differences, including increased risk of homicide among second generation immigrants, were partly explained by differences in family income whereas ethnic group had an independent protective effect on risk of death due to accidents and suicides.

The dose dependent association between mortality and income was further displayed by spline curves (figure 6). Modelling income as a continuous variable illustrated the shape of associations in more detail

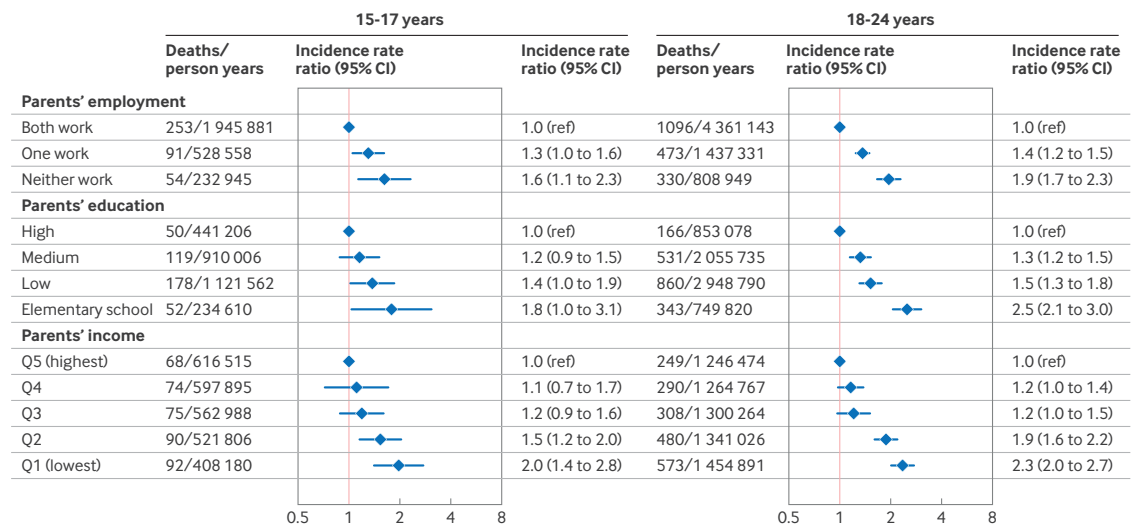


Figure 4 | Deaths per person year, incidence rate ratios, and 95% confidence interval (95% CI) by age group and parents' socioeconomic position in 15-24-year-olds, in Denmark, 2010-22. Q=quintile

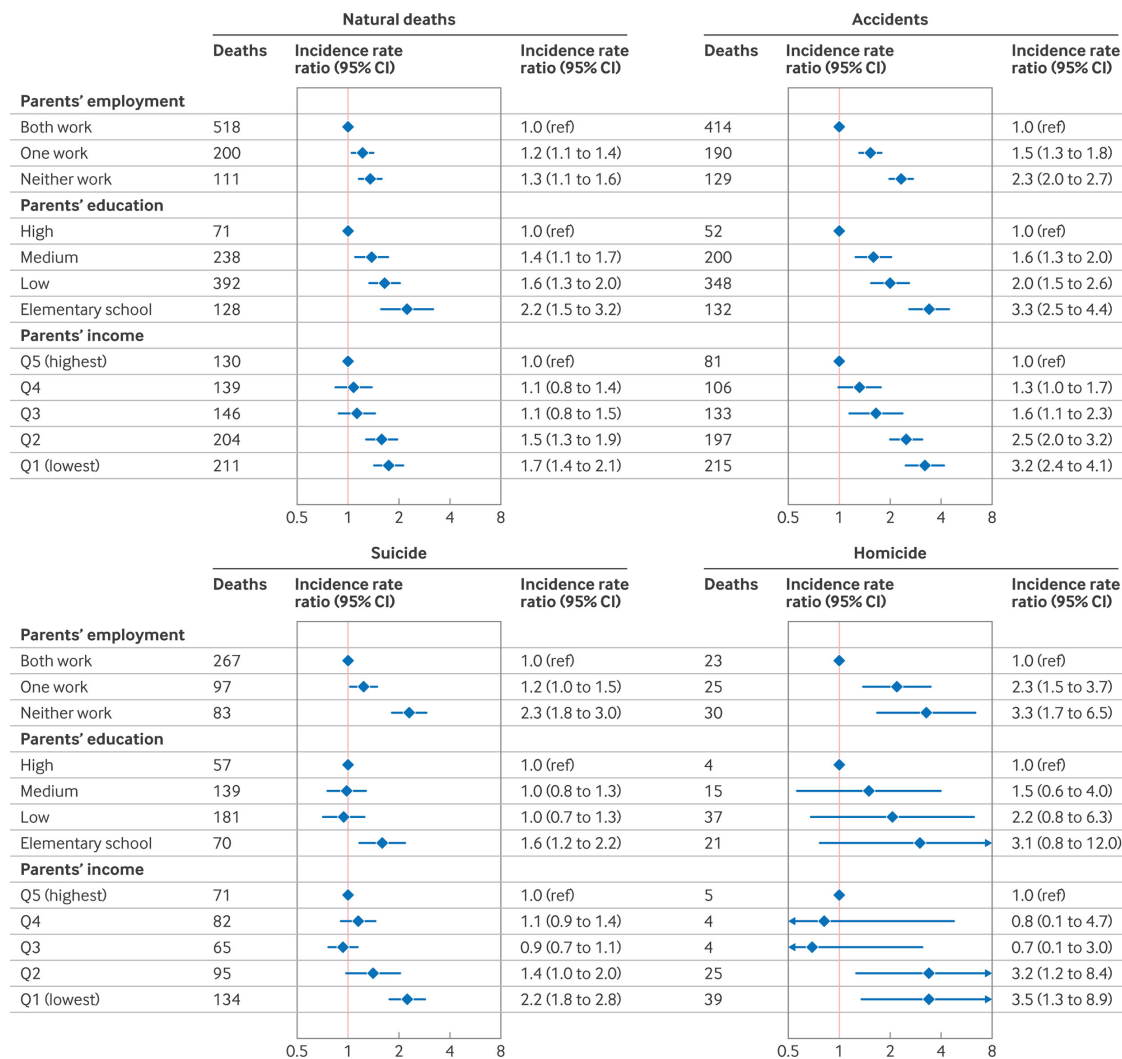


Figure 5 | Deaths, incidence rate ratios, and 95% confidence interval (95% CI) by manner of death and parents' socioeconomic position in 15-24-year-olds, in Denmark, 2010-21. Q=quintile

and showed that the 60% least affluent individuals were those for whom income had the most effect on mortality rates. This pattern seemed to replicate across causes of deaths including natural deaths.

Discussion

Key results

In this nationwide study of all deaths in 15-24-year-olds during 2010 to 2022 in Denmark, we reported that mortality in young people was consistently socially patterned. This result was observed for three measures of socioeconomic position (parent's employment status, educational level, and income). All cause mortality as well as cause specific mortality were markedly higher in socioeconomic disadvantaged groups compared with more affluent groups. Dose dependent associations generally showed higher mortality from natural deaths (ie, medical conditions and diseases), accidents, suicides, and homicides with lower levels of socioeconomic position. Modelling income showed socioeconomic inequality across incomes and the gradient

was especially steep for the 60% less affluent individuals. Results were similar in young men and women and between age groups (15-17-years-old v 18-24-year-olds).

Our results support previous indications of socioeconomic inequality in mortality in young people.^{10 12 14 29 30} We observed a consistent social gradient in natural deaths which is as novel a finding as no socioeconomic inequality in medical mortality reported in previous studies in young men and women.^{11 12 30} These studies used various measures of socioeconomic position such as social class, housing tenure, car access, and manual versus non-manual work. Our findings add a more distinct and finely divided social gradient that also includes the large middle class and is not limited to marginalised groups.

Mechanisms

Mechanisms explaining the association between social inequality and mortality in young people are complex and not fully understood. As described in

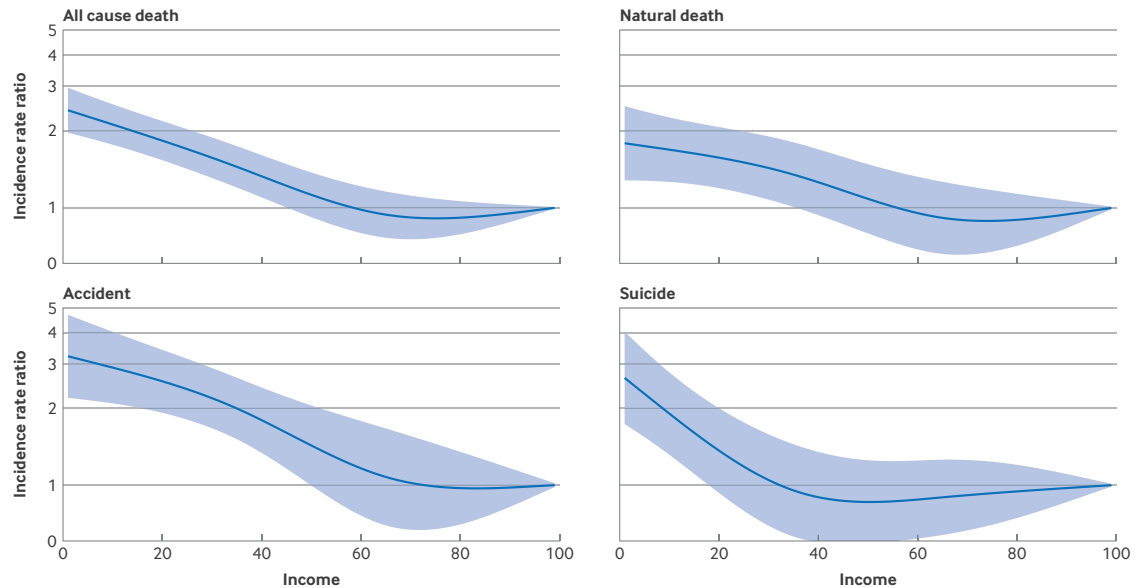


Figure 6 | Incidence rate ratios, shown by a dark blue line (lighter blue indicates 95% confidence interval), of all cause death, natural death, death due to accidents, and suicides by income percentiles from lowest (0) to highest (100) in 15-24-year-olds in Denmark, 2010-21. Adjusted for gender, age, immigration status, and calendar year

1995, socioeconomic factors are likely fundamental causes of disease because money, knowledge, power, prestige, and social network are resources that influence the extent to which people avoid risks for morbidity and mortality.³¹ Socioeconomic factors are fundamental because they persistently affect multiple disease outcomes via multiple risk factors, and they are passed on through generations. Although the extent of socioeconomic mobility is continuously under debate, socioeconomic position is hereditary.³²

Some types of cancers that lead to natural death are associated with the accumulation of risk factors over time and socioeconomic position is a determinant of exposure, acting through living conditions, work environment (eg, toxins and psychosocial stress), and health behaviour (eg, smoking and alcohol use). Social inequality that affects mortality in young people may also result from differences in discovery, diagnosis, and treatment of diseases. Denmark is a welfare society with free access to high quality welfare benefits including medical services at all levels. Yet, tackling a course of a disease also requires health literacy, compliance to treatment, and the ability to navigate and understand the healthcare system.³³ These issues are where parents' educational level is likely to have a large effect because longer education reduces the effect of these potential barriers and therefore a favourable disease outcome, as outlined by the theory of fundamental causes.³¹

The mechanisms of inequality may differ in nature depending on the manner of death, most importantly if the death is caused by natural or unnatural causes. Unnatural as opposed to natural deaths are the ultimate result of an immediate event, such as a traffic accident or a suicide. Adolescence constitutes

the important transitional period from child to adulthood entailing more dependence, orientation towards peers, and social mobilisation—all factors that are associated with increased autonomy.³⁴ During this period, the young brain is further developed including the maturing of the frontal lobe that is responsible of executive functions, planning, reasoning, and impulse control, alongside remodelling of the dopaminergic system that is essential in reward and sensation-seeking behaviour. These are adjustments that help young people to assess external risks such as situations in the traffic,^{35 36} Socioeconomic position correlates with differential susceptibility to exposures and willingness to engage in risk behaviours,³⁷ even more pronounced in children and young people who are experiencing distress in the form of adverse childhood experiences,³⁸ which are also more frequent in those who have parents with low socioeconomic position.

Accidents were a common cause of death accounting for 35% of all deaths and 58% of unnatural deaths in 15 -to-24-year-olds in Denmark from 2010 to 2022. A high alcohol intake in young people may also be a factor because accidents are sometime related to alcohol intake,¹⁸ and studies have shown that alcohol causes disproportionately more harm in disadvantaged groups compared with more affluent groups.^{39 40} Differences in drinking patterns between socioeconomic groups have been proposed to explain a maximum of 30% of the variability in alcohol related harm⁴¹ However, in a recent prospective cohort study, alcohol-related harm in young people was more common in socioeconomically disadvantaged adolescents despite similar levels of alcohol consumption, regardless of differences in drinking pattern or substance use.⁴²

Employment status somewhat mirrors parental level of functioning and receiving public benefits is associated with chronic illness and other functional disabilities,⁴³ which in turn, can cause reduced family functioning and social-emotional and behavioural problems in young people.⁴⁴ Furthermore, economic hardship may cause disruption of supportive parenting behaviours as described in the family stress model,⁴⁵ compromising parental monitoring and support, which might lead to more risky and adverse health behaviours in young men and women. A mix of accumulating environmental exposures, health risk behaviour, and differences in vulnerability may constitute some of the mechanisms explaining a social pattern in mortality in young people.

Strengths and limitations

A considerable strength is that we used complete and annually updated data from nationwide registers including all 15-to-24-year-olds during the study period. We considered the risk of bias due to selection and misclassification to be negligible. We operationalised socioeconomic position with three measures, each one contributing to cover attributes and resources affecting life circumstances and health. Parents' employment mirrored functional level and health, education represented an indicator of parent knowledge, and family income represented an indicator of financial and material resources. Including all three measures provides a more detailed definition of socioeconomic position and allowed us to detect possible differences between the measures. The measures are connected and are of different importance during a life course.⁴⁶ Socioeconomic position, however, was a proxy for other determinants and resources of diverse nature in turn affecting major determinants of health such as environmental exposure, health behaviour, and healthcare.⁴⁷

Fortunately, premature death in young men and women is relatively rare. Consequently, even though all deaths occurring during the study period were included, statistical power was low especially for suicide and homicide. Nevertheless, a pattern of social imbalance was systematically observed across all causes of death. Of note, we did not differentiate between one parent and two parent households, which may have affected results. Also, our model for associations between socioeconomic position and mortality from natural deaths was not adjusted for the affect on income that may come from having a sick child.

Conclusion and implications

Inequality in child⁴⁸ and adult^{49 50} mortality has been systematically documented, while disparities in mortality in young people have received less attention. We found that premature death in 15-to-24-year-olds

was consistently associated with parents' socioeconomic background for natural and unnatural causes, such as accidents, suicide, and homicide. Importantly, these socioeconomic inequalities were not confined to a specific marginalised group but were observed through the range of socioeconomic position in a dose-dependent shape, with the highest mortality rates observed among less affluent groups. Deaths in young people due to unnatural causes, accounting for 60% of all deaths in our study, have a substantial preventive potential. Rates of mortality in young people have changed relatively little and less than rates in young children and adults over recent years.⁶ This indicates that adolescent health should be given priority. Considering the neurobiology of the adolescent brain characterised by risk taking and reward seeking behaviour, youth constitutes a unique time in life of heightened vulnerability, which calls for special attention in the context of public health. This study provides only a brief overview of the socioeconomic inequality issue in adolescent health because the outcome of death used in this study represents the final outcome of diseases and health related factors. Gaining a deeper understanding of the underlying mechanisms is crucial in addressing these inequities and promoting better young people health.

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Contributors JST and SK had the idea for the paper, planned, and designed the study. SK was responsible for first drafting of the manuscript and literature search. JST did the statistical analysis. Both authors discussed the results and contributed to the final manuscript. Both authors have seen and approved of the final manuscript. JST is the guarantor. The corresponding author (JST) attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. **Transparency:** The lead author (the guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Ethical approval was not required as the project was register based. Use of data was registered at and approved by the Danish Data Protection Agency. All requirements for data protection and handling were fulfilled. The study did not require the consent of individual patients in accordance with the Danish Data protection Agency.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data can be shared after reasonable request to the corresponding author.

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