Social inequalities in road traffic deaths at age 16—20 years among all 611,654 Norwegians born between 1967 and 1976: a multilevel analysis

Petter Kristensen,1,2 Thomas Kristiansen,3 Marius Rehn,3,4 Hans Magne Gravseth,2 Tor Bjerkedal1,5

ABSTRACT

Background Road traffic injury is a major cause of death among youths.
Aims To estimate mortality differences in family socioeconomic position (SEP) and municipal disadvantage level.
Methods Data on all Norwegians born in 1987—76, gathered from national registries, were linked by a unique national identification number. The 611,654 participants were followed-up for 5 years from age 16 years. Parental education level, father’s income level, and proportion of high-income earners in the municipality served as SEP indicators. Associations between SEP and road traffic deaths were analysed by multilevel Poisson regression.
Results Road traffic deaths (n = 676, rate 22.2 per 100,000 person-years) constituted a major cause of death, of which 91.9% were motor vehicle occupants. SEP distributions differed according to gender and type of motor vehicle crash (collision, non-collision). There was an inverse relationship between municipal proportions of high-income earners and mortality (population attributable fraction (PAF) 0.43, 95% CI 0.30 to 0.53) in all categories of gender-specific crash types. Family SEP gradients were not found except for male non-collision deaths, where increasing mortality was found in association with decreasing parental education level (PAF 0.94, 95% CI 0.59 to 0.99) and increasing paternal income (PAF 0.25, 95% CI 0.06 to 0.40).

Conclusion The different SEP patterns for road traffic deaths across gender and motor vehicle crash type illustrate that heterogeneity of social inequalities in health can be found even within narrow age bands and for similar causes of death.

Road traffic injury is a major public health problem worldwide and those most at risk are consistently the economically deprived.1 The death toll is largest in developing countries, but road traffic injury is still the leading cause of injury death in developed countries and socioeconomic gradients are not decreasing.2—4

Injury epidemiology addressing social inequalities applies explanatory models that include both individual and contextual factors.4—10 However, epidemiological studies addressing both individual and area indicators of socioeconomic position (SEP) in multilevel analysis are still few.8—10

Socioeconomic gradients in transport injuries have been documented in several reviews1—5 and numerous studies.8—20 Among these, several studies were restricted to youths or performed separate analyses among adolescents and young adults.10—16 SEP indicators in studies covering adolescents have mostly been family based—for example, parental occupational class, education level, and income. Family occupational class, education, and income were interrelated in a Swedish study addressing SEP gradients among young car drivers, and education had a slightly higher impact on road traffic injuries than occupation, whereas income had only marginal impact.14 There are no consistent results concerning area level SEP indicators.8—10 In the US National Health Interview Survey, motor vehicle deaths in a broad age range were associated with neighbourhood poverty, low income, blue collar occupation, and low education.7

There are several indications that social inequalities in road traffic injuries vary across age, gender, road user type, and category of injury. In general, equalisation in SEP gradients is found in youth.21 22 However, road traffic injury data in Sweden, restricted to those aged 2—24 years, suggest that differentials increase at the age when young people start using motorised vehicles.11 In general, social inequalities in health have been found to be steeper for males than females, but this has not been confirmed for road traffic injuries.3—11 There is also variation in socioeconomic disparities among youths according to injury cause,10 with larger differences for injuries among motor vehicle occupants11 and specific motor vehicle crash circumstances.12 Such heterogeneity of social inequalities in road traffic injuries has not been extensively studied, but should not be unexpected considering the intricate causal pathways linking social factors and health.21 23

We have established a register-based cohort comprising all live-born in Norway during 1967—76,24 including repeated individual and area characteristics recorded throughout life. Road traffic mortality in this cohort was at its highest between ages 16 and 20 (figure 1). This overlaps with the age when licensed driving is first permitted, which is 16 years for lightweight motorcycle riders and 18 years for car drivers. We decided to restrict the follow-up to the five high-risk years between ages 16 and 20. The main objective was to investigate socioeconomic differentials in road traffic mortality on the individual and community level according to gender, road user type, and injury type. We expected steeper socioeconomic gradients for males than for females. We also anticipated that residents in economically disadvantaged areas would be at increased risk.
information in the Norwegian Social Science Data Services, we found that the proportion of all income earners who paid surtax to the state in 2000 and the proportion of inhabitants with tertiary education in 1990 were most strongly associated with road traffic mortality. Analyses with both these indicators resulted in collinearity as they correlated strongly (correlation coefficient 0.825). We therefore decided to use the variable with the strongest correlation with road traffic mortality, which was proportion of high-income earners. The variable was categorised in quartiles, with decreasing high-income earners indicating municipal disadvantage.

Higher road traffic death rates have been found in rural areas than urban areas in a number of studies.9 13 25 We therefore applied municipal urbanisation based on Statistic Norway’s standard classification of centrality (http://www3.ssb.no/stabas/ItemsFrames.asp?ID=5290001&Language=en), classifying 232 municipalities as urban and 203 as rural. A municipality was defined as rural if travelling to an urban settlement took at least 45 min, according to Statistics Norway’s standard.

Distribution of the independent individual and municipal variables that were applied in the analyses is provided in table 1.

The main study outcome was death from a road traffic injury, notified during follow-up. The Cause of Death Register used ICD-8, ICD-9, and ICD-10 during the study period. Codes according to road user type are specified in table 2. Occasional deaths following motor vehicle crashes were also considered according to crash category. Non-collision deaths represent events due to loss of control on the road (ICD-8 E816, ICD-9 E816, ICD-10 V28/V48), excluding vehicle-to-vehicle impact. The remaining motor vehicle crashes were termed collision crashes.

Statistical analysis

We used Stata/SE 11.1 software. Person-time at risk was computed for each participant during follow-up, or death or emigration, whichever occurred first. Deaths rates due to road traffic injuries with subgroups according to road user type were computed per 100 000 person-years at risk. Rate ratio (RR) with accompanying 95% CI was estimated in multilevel mixed effects Poisson regression models, applying Stata’s xtmepoisson option with a random intercept without any random coefficients. Models included five individual-level and two municipality-level variables: year of birth (continuous), gender, parental education (five levels), father’s income level (quartiles), mother’s marital status (dichotomous), high-income earners in municipality (quartiles), and municipal urbanisation (dichotomous). Missing values for individual characteristics were included as separate categories, but because the xtmepoisson regression did not converge for cells with zero deaths we had to omit participants with missing parental education level.

We also computed adjusted population attributable fraction (PAF) for the socioeconomic indicators (parental education, father’s income, and high-income earners in the municipality) using ordinary Poisson regression and Stata’s alogit procedure. Here, dummy variables were applied for all values except the reference value, which were tertiary high parental education, the lowest quartile of father’s income, and the highest quartile of municipal high-income earners. Observations with missing data for the predictor were excluded.

RESULTS

Road traffic mortality

The total follow-up counted 3,047,849 person-years (mean 4.98 years). During follow-up, 5,787 participants emigrated and
Table 1  Distribution of descriptive characteristics and road traffic deaths for 611 654 Norwegians born between 1967 and 1976 and followed-up from age 16 to 20 years

| Characteristic                      | No.   | %      | No. of deaths | Rate*   |
|-------------------------------------|-------|--------|---------------|---------|
| **Individual level variables**      |       |        |               |         |
| Gender                              |       |        |               |         |
| Females                             | 298 466 | 48.8   | 149           | 10.0    |
| Males                               | 313 188 | 51.2   | 527           | 33.8    |
| Year of birth                       |       |        |               |         |
| 1967–68                             | 130 136 | 21.3   | 192           | 29.6    |
| 1969–70                             | 129 069 | 21.1   | 172           | 26.7    |
| 1971–72                             | 126 588 | 20.7   | 123           | 19.5    |
| 1973–74                             | 118 038 | 19.3   | 101           | 17.2    |
| 1975–76                             | 107 339 | 17.6   | 88            | 16.5    |
| **Parental education level**        |       |        |               |         |
| Tertiary, high (class level 17+)    | 42 811 | 7.0    | 22            | 10.3    |
| Tertiary, low (class level 14–16)   | 110 226 | 18.0   | 70            | 12.7    |
| Upper secondary, complete (class level 12–13) | 121 336 | 19.8 | 133 | 22.0 |
| Upper secondary, basic (class level 10–11) | 244 193 | 39.9 | 295 | 24.3 |
| Lower secondary or less (class level 0–9) | 91 246 | 14.9 | 153 | 33.7 |
| **Father’s income quartile**        |       |        |               |         |
| Highest                             | 142 255 | 23.3   | 124           | 17.5    |
| Third                               | 142 274 | 23.3   | 147           | 20.8    |
| Second                              | 142 319 | 23.3   | 158           | 22.3    |
| Lowest                              | 142 283 | 23.3   | 188           | 26.5    |
| Missing                             | 42 523  | 7.0    | 59            | 28.4    |
| **Mother’s marital status**         |       |        |               |         |
| Married                             | 501 622 | 82.0   | 527           | 21.1    |
| Unmarried                           | 102 728 | 16.8   | 135           | 26.4    |
| Missing                             | 7304    | 1.2    | 14            | 38.5    |
| **Municipal level variables (six missing)** |       |        |               |         |
| Proportion high-income earners (quartiles)† |       |        |               |         |
| 0.280–0.402                         | 152 280 | 24.9   | 97            | 12.8    |
| 0.224–0.279                         | 152 903 | 25.0   | 152           | 19.9    |
| 0.177–0.223                         | 153 955 | 25.2   | 196           | 25.6    |
| 0.024–0.176                         | 152 510 | 24.9   | 231           | 30.4    |
| **Urbanisation‡**                  |       |        |               |         |
| Urban                               | 506 080 | 82.7   | 515           | 20.5    |
| Rural                               | 105 568 | 17.3   | 161           | 30.6    |

*Deaths per 100,000 person-years.
†Proportion of income earners who paid surtax to the state in 2000.
‡The municipality's geographical position in relation to an urban settlement.

1922 (rate 65.1) died. More than one-third of all deaths were related to road traffic incidents (n=676, rate 22.2). Crude road traffic mortality increased steeply by decreasing levels of parental education and municipal high-income earners whereas the association with decreasing paternal income was more moderate (table 1). Rates were also considerably higher among males and moderately higher for participants with unmarried mothers and those residing in rural municipalities.

The mortality distribution according to gender and road user category is shown in table 2. Motor vehicle occupants (n=621, rate 20.4) constituted more than 90% of the total. Death rates were higher for men than for women in all road user categories, and the largest gender differences were found for motorcycle riders and car drivers. The highest male motorcycle rider mortality was found at age 16 (42 deaths, rate 13.5); 18-year-old males had the highest car driver mortality (82 deaths, rate 26.5). The proportion of deaths among motor vehicle occupants that were classified as non-collision was higher for males (0.525) than for females (0.445).

Table 2  ICD codes for fatal road traffic injuries and number of deaths according to gender and road user type for 611 654 Norwegians born between 1967 and 1976 and followed-up from age 16 to 20 years

| Category                               | Females | Males |
|----------------------------------------|---------|-------|
| **Total road traffic injuries**        |         |       |
| ICD-8 (1983–85)                        |         |       |
| E810–E819, last digit 9                |         |       |
| E810–E819, last digit 9                | 149     | 527   |
| E826–E829                              |         |       |
| V01–V29, rate 20.4                     | 43      | 210   |
| V40–V49 last digit 5                   | 68      | 139   |
| V40–V49 last digit 6                   | 8       | 116   |
| V20–V29 last digit 4                   | 6       | 10    |
| V20–V29 last digit 5                   | 3       | 18    |
| **Unspecified motor vehicle occupant†**|         |       |
| E810–E819, last digit 9                | 21      |       |
| E810–E819, last digit 9                |         |       |
| **Other**                              |         |       |
| ICD-9 (1986–95)                        |         |       |
| ICD-10 (1996–97)                       |         |       |
| V01–V29, rate 20.4                     |         |       |
| V40–V49 last digit 5                   |         |       |
| V40–V49 last digit 6                   |         |       |
| V20–V29 last digit 4                   |         |       |
| V20–V29 last digit 5                   |         |       |
| **Multivariate results**               |         |       |

Results for all road traffic deaths in the multilevel Poisson regression are provided in table 3. Dose-dependent RR increases were apparent for decreasing parental education level and decreasing levels of municipal high-income earners. Adjusted RRs for categories of paternal income were close to unity with a tendency of RRs below unity for low income. Separate analyses for males and females showed risk pattern differences. Notably, males had distinctive mortality increases in association with decreasing parental education level; such a pattern was absent for females. Decreasing levels of municipal high-income earners were associated with increasing mortality (PAF 0.43, 95% CI 0.30 to 0.53). The females experienced only 149 deaths and the association estimates had wide confidence limits.

The relationship between SEP and mortality was examined in more detail by performing gender-specific analyses of non-collision and collision deaths (table 4). Additional analyses stratified on road user category (rider/driver, passenger) and motor vehicle type (car, motorcycle) did not alter the pattern in table 4 and are therefore not shown. Municipal disadvantage was more strongly associated with collision deaths than non-collision deaths for both genders, and female non-collision deaths lacked a consistent trend.

The family SEP indicators were not associated with the outcomes in the four subsets, with the exception of male non-collision deaths (table 4). Male non-collision mortality was strongly associated with decreasing parental education level with a more than 10-fold RR increase in the lowest level. Furthermore, male non-collision death was significantly lower in association with the lowest paternal income quartile.
Considering the decreasing crude mortality by increasing income, this was unexpected. The main explanation is that the 17,822 males with lowly educated parents (below completed upper secondary) and high-income fathers had a distinctive high non-collision driver death rate (21 driver deaths, rate 23.6). The 54,273 males from families with both low income and education numbered 34 drivers in fatal non-collision crashes (rate 12.6).

The PAF estimates in the four gender-crash type categories in table 4 showed the same pattern as the RR estimates. Municipal disadvantage PAF estimates were 0.52 (95% CI 0.04 to 0.78), 0.56 (95% CI 0.14 to 0.77), 0.39 (95% CI 0.15 to 0.56), and 0.48 (95% CI 0.26 to 0.64) for female non-collision, female collision, male non-collision, and male collision mortality, respectively. The only significant PAF estimates for family SEP indicators were found in the male non-collision category: 0.94 (95% CI 0.59 to 0.99) for decreasing parental education and 0.25 (95% CI 0.06 to 0.40) for increasing paternal income.

Table 4 also shows that the male non-collision death category was the only category with an increased RR in association with rural municipalities. Sons and daughters of unmarried mothers also had increased RRs in association with non-collision but not collision death.

**DISCUSSION**

Road traffic injury was a major cause of death in this young population and more than 90% were motor vehicle occupants. The highest male death rates were observed at an age when they were entitled to obtain a driver’s license. In multilevel analysis taking individual factors into account, fatal motor vehicle injury rates increased with increasing levels of municipal disadvantage. Associations with family SEP indicators were almost only restricted to male non-collision deaths, showing steeply increasing mortality with decreasing levels of parental education and more moderate mortality increases by increasing levels of paternal income.

**Strengths and limitations**

This multilevel study was based on complete linkage between national registries, which renders selection bias an unlikely problem. Information bias and confounding are more plausible limitations when using national registries, as data are often collected for purposes other than research. There may be limitations related to data quality as well as a lack of information on potentially important factors. The time-at-risk data were approximates because we had no data on road traffic exposure. Ideally, driver’s license information and individual driver and

### Table 3  Road traffic deaths (n=676) according to gender, in association with individual and municipal characteristics, for 609,807 Norwegians born between 1967 and 1976 and followed-up from age 16 to 20 years*

| Characteristic                  | Total RR | 95% CI | Females RR | 95% CI | Males RR | 95% CI |
|--------------------------------|----------|--------|------------|--------|----------|--------|
| **Individual level variables** |           |        |            |        |          |        |
| Gender                         | 1 Ref.   | 1 Ref. | 1 Ref.     |        |          |        |
| Female                         | 3.35     | 2.79 to 4.01 | 0.93     | 0.90 to 0.95 | 0.92 | 0.89 to 0.96 |
| Male                           | 0.94     | 0.87 to 1.01 | 0.94     | 0.87 to 1.01 | 0.92 | 0.89 to 0.96 |
| Year of birth                  |          |        |            |        |          |        |
| Tertiary, high                 | 1.17     | 0.72 to 1.91 | 2.01     | 1.27 to 3.20 | 2.04 | 1.29 to 3.22 |
| Parental education level       |          |        |            |        |          |        |
| Tertiary, low                  | 0.78     | 0.33 to 1.82 | 1.12     | 0.49 to 2.53 | 1.18 | 0.53 to 2.61 |
| Upper secondary, complete      | 0.41     | 0.25 to 0.70 | 2.55     | 1.44 to 4.52 | 2.56 | 1.46 to 4.51 |
| Upper secondary, basic         | 1.41     | 0.77 to 2.33 | 1.12     | 0.47 to 2.66 | 2.63 | 1.65 to 4.28 |
| Lower secondary or less        | 0.83     | 0.56 to 1.26 | 1.04     | 0.71 to 1.52 | 1.30 | 0.87 to 1.96 |
| Father’s income quartile       | 1 Ref.   | 1 Ref. | 1 Ref.     |        |          |        |
| Highest                        | 0.89     | 0.67 to 1.09 | 0.85     | 0.72 to 2.23 | 1.08 | 0.77 to 2.43 |
| Third                          | 1.12     | 0.90 to 1.36 | 1.31     | 0.77 to 2.33 | 1.17 | 0.76 to 1.84 |
| Second                         | 0.87     | 0.67 to 1.09 | 1.34     | 0.76 to 2.33 | 1.17 | 0.76 to 1.84 |
| Lowest                         | 0.83     | 0.67 to 1.09 | 1.34     | 0.76 to 2.33 | 1.17 | 0.76 to 1.84 |
| Missing                        | 1.04     | 0.71 to 1.52 | 1.04     | 0.71 to 1.52 | 1.04 | 0.71 to 1.52 |
| Mother’s marital status        | 1 Ref.   | 1 Ref. | 1 Ref.     |        |          |        |
| Married                        | 1.31     | 1.07 to 1.59 | 0.83     | 0.76 to 1.09 | 1.59 | 0.93 to 2.71 |
| Unmarried                      | 0.93     | 0.76 to 1.19 | 0.93     | 0.76 to 1.19 | 0.93 | 0.76 to 1.19 |
| Missing                        | 1.07     | 0.87 to 1.36 | 1.07     | 0.87 to 1.36 | 1.07 | 0.87 to 1.36 |
| Municipal level variables      | 1 Ref.   | 1 Ref. | 1 Ref.     |        |          |        |
| Proportion high-income earners (quartiles) | 1 Ref.  | 1 Ref. | 1 Ref.     |        |          |        |
| Highest                        | 1.41     | 1.01 to 1.97 | 1.84     | 1.04 to 3.25 | 1.36 | 0.96 to 1.94 |
| Third                          | 1.72     | 1.24 to 2.38 | 1.80     | 1.00 to 3.24 | 1.79 | 1.27 to 2.51 |
| Second                         | 1.94     | 1.39 to 2.71 | 2.53     | 1.37 to 4.67 | 1.93 | 1.35 to 2.75 |
| Lowest                         | 1.08     | 0.86 to 1.40 | 0.79     | 0.59 to 1.19 | 0.79 | 0.59 to 1.19 |
| Urban                          | 0.86     | 0.60 to 1.24 | 0.79     | 0.59 to 1.19 | 0.79 | 0.59 to 1.19 |
| Rural                          | 0.79     | 0.59 to 1.09 | 0.79     | 0.59 to 1.09 | 0.79 | 0.59 to 1.09 |
| Random effect, intercept variability (SE) | 0.116    | (0.046)  | 0.035     | (0.172) | 0.079 | (0.057) |

*1847 Participants with missing data on parental education or municipality were not included in the analysis. RR in a model including gender, year of birth, parental education level, father’s income level, mother’s marital status, municipal proportion of high-income earners, and municipal urbanisation.
Table 4 Motor vehicle occupant death (n=621) according to gender and type of crash, in association with individual and municipal characteristics, for 609,807 Norwegians born between 1967 and 1976 and followed-up from age 16 to 20 years.

| Characteristic       | Females Non-collision† (57 deaths) | Females Collision† (71 deaths) | Males Non-collision‡ (259 deaths) | Males Collision‡ (234 deaths) |
|----------------------|-------------------------------------|---------------------------------|-----------------------------------|--------------------------------|
|                      | RR  | 95% CI RR  | 95% CI RR  | RR  | 95% CI RR  | 95% CI |
| Individual level variables |      |         |            |      |         |
| Year of birth         | 0.90 | 0.81 to 1.00 | 0.80 to 1.11 | 0.92 | 0.87 to 0.96 |
| Parental education level |    |               |            |      |         |
| Tertiary, high        | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. |
| Tertiary, low         | 0.36 | 0.07 to 1.86 | 0.03 to 2.90 | 0.09 | 0.91 to 10.27 |
| Upper secondary, complete | 1.42 | 0.39 to 2.42 | 0.10 to 4.31 | 2.64 | 1.69 to 18.57 |
| Upper secondary, basic | 1.08 | 0.29 to 3.98 | 0.07 to 3.59 | 6.72 | 2.09 to 21.58 |
| Lower secondary or less | 1.37 | 0.34 to 5.44 | 0.20 to 3.28 | 10.21 | 3.13 to 34.89 |
| Father's income quartile |    |               |            |      |         |
| Highest               | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. |
| Third                 | 0.74 | 0.20 to 2.93 | 0.15 to 2.71 | 0.67 | 0.51 to 1.40 |
| Second                | 0.57 | 0.22 to 1.35 | 0.15 to 2.35 | 0.37 | 0.18 to 0.79 |
| Lowest                | 1.30 | 0.57 to 3.17 | 0.08 to 4.92 | 2.17 | 1.04 to 4.51 |
| Missing               | 1.34 | 0.44 to 4.04 | 0.11 to 4.73 | 0.65 | 0.30 to 1.43 |
| Mother's marital status |      |               |            |      |         |
| Married               | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. |
| Unmarried             | 2.06 | 1.14 to 3.71 | 0.34 to 1.42 | 1.67 | 1.23 to 2.25 |
| Missing               | 1.41 | 0.19 to 10.36 | 0.04 to 4.27 | 2.18 | 1.02 to 4.64 |
| Municipal level variables |      |               |            |      |         |
| Proportion high-income earners (quarters) | |          |        |      |         |
| Highest               | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. | 1 Ref. |
| Third                 | 2.74 | 1.14 to 6.55 | 0.74 to 4.33 | 1.14 | 0.71 to 1.83 |
| Second                | 2.19 | 0.88 to 5.45 | 0.70 to 4.43 | 1.66 | 1.06 to 2.59 |
| Lowest                | 1.88 | 0.69 to 5.13 | 1.48 to 9.14 | 1.76 | 1.10 to 2.81 |
| Urbanisation          |      |               |            |      |         |
| Urban                 | 1.15 | 0.54 to 2.43 | 0.31 to 2.10 | 1.66 | 1.02 to 2.39 |
| Rural                 | 0.56 | 0.24 to 1.30 | 0.13 to 1.20 | 0.72 | 0.49 to 1.07 |
| Random effect, intercept variability (SE) | 0.000 | (0.000) | 0.013 | (0.323) | 0.086 | (0.104) |

*1847 participants with missing data on parental education or municipality were not included in the analysis.
†Non-collision: ICD-8 E816; ICD-9 E816; ICD-10 V28/V48: non-collision motor vehicle crash due to loss of control on the road. Collision: other motor vehicle crashes.
‡RR in a model including gender, year of birth, parental education level, father's income level, mother's marital status, municipal proportion of high-income earners, and municipal urbanisation.

The association with low paternal income could be underestimated if paternal income level, whereas occupational class data were unavailable. Occupational class has often been used in epidemiological studies addressing social inequalities in health, but for more serious injuries than for less serious injuries, and for road traffic injuries dominated by motor vehicle events than broader categories of transport-related injuries. Only a few studies have estimated area effects, taking individual factors into consideration. The association with municipal disadvantage in the present study is in agreement with findings in the US National Health Interview Survey. An opposite result was found in Stockholm county where injury odds among motor vehicle riders below age 17 decreased in association with increasing parish level deprivation. This discrepancy could be due to the low age and the probable domination of moped riders in the Swedish study.

The family SEP gradient in our study was restricted to males in non-collision crashes. To the best of our knowledge, there is only one other study addressing injury risk in young adults according to socioeconomic level, gender, and type of crash. Hasselberg et al found that single vehicle (comparable to non-collision) crash patterns showed some similarities with our findings, but the strength of associations and the clear distinction between single vehicle and other crash types were not found. It is also interesting that Hasselberg and Laflamme reported a reversal of the family income gradient in injury risk after adjustment for parental education, just as in our study.

The increased mortality in association with a rural residence is in agreement with several earlier reports, and could be...
explained by more serious crashes as well as delayed receipt of medical care in remote areas. Moderate associations between road traffic injury and single parents have been reported in some studies. This could be in accord with the moderate mortality excess among participants with unmarried mothers in our study. However, we found a specific association with female and male non-collision crashes, and this has, to the best of our knowledge, not been reported earlier.

Interpretations and implications
The results provide documentation that SEP gradients in road traffic mortality are diverse: there is an overall gradient according to neighbourhood disadvantage and a complex SEP gradient on the family level for male non-collision mortality. The documentation of diverse SEP gradients in this study, which covers a seemingly strictly defined outcome and a narrow age band, illustrates that the causal pathways linking social factors and health can be intricate. The gender-specific socioeconomic patterns are further indications of complex pathways between societal distribution of determinants and health outcomes. We believe that the results of the present study could prove useful in our general understanding of social inequalities in health.

There are several indications that high-risk behaviour partly explains the high rates and distinct socioeconomic pattern in male non-collision deaths. Causal models for road traffic injuries emphasise the division between exposure level and exposure susceptibility (risk proneness). The association with high levels of parental income suggests increased car access and higher exposure (more kilometres) as part of the explanation. The association with a rural residence could also be explained by higher exposure, but speeding in remote areas could result in more fatalities per crash as well. Exposure surveys in Norway suggest that a considerable portion of the male excess mortality cannot be explained by exposure level. Nor did exposure explain SEP gradients in road traffic injuries in Australia. Another Norwegian survey indicates that males are considerably more prone than females to exceed speed limits. Non-collision injuries among young males have been associated with impaired driving and unlicensed driving in Swedish studies.

The strong negative association between parental education and fatal male non-collision crashes could be explained by a mediating mechanism. Adolescent psychosocial adjustment and risk-taking behaviour have been shown to predict novice traffic incidents. Increasing parental education level has been associated with parental support and child behavioural competence and coping. Furthermore, parental support and monitoring are related to adolescent risk-taking and crash levels. Accordingly, parental education could influence support and monitoring, which in turn could affect risk-taking behaviour and crash risk.

Road safety strategies and legislation in Norway are similar to those in other developed European countries. Road traffic mortality among youths in developed countries is a leading cause of death and shows socioeconomic gradients, suggesting that results of the present study are not only valid for Norway. Mortality was decreasing for later born participants and we could question whether results from the follow-up during 1983–96 would be valid for more recent years. However, the relative dominance of road traffic deaths still prevails and socioeconomic gradients are not decreasing.

Prevention of road traffic injuries is not given sufficient priority. The combined effects in the present study of municipal disadvantage and SEP gradients in the family suggest that both community-based and family interventions should be further strengthened. Graduating licenses having had effects in countries with a lower licensing age. Such policies could improve in effectiveness if parents were more strongly involved.

What is already known on the subject
- Motor vehicle injury is a main cause of death in the late teens and early twenties in high-income countries.
- There are socioeconomic inequalities in injury rates and mortality, but the relative contribution of area disadvantage and individual socioeconomic position is not clear.

What this study adds
- The socioeconomic pattern for mortality among motor vehicle occupants aged 16–20 years was distinctly different according to gender and crash type.
- There was a strong road traffic mortality gradient according to municipal degree of disadvantage. Male death after a non-collision crash was the only category showing strong socioeconomic gradients on the family level, with increased mortality for decreasing paternal education level and high paternal income level.
- Community-based preventive programmes are important in order to reduce social inequalities in road traffic deaths in adolescence and young adulthood, but should be supplemented with more targeted actions aimed at the high-risk male group.

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Ethics approval This study was conducted with the approval of the Regional Committee for Medical Research Ethics.

Contributors All authors meet the uniform requirements for manuscripts submitted to medical journals. TB and PK had the initial idea of the study and established the data file. PK was responsible for study design, analyses, and drafting the article. TB, TK, MR, and HMG oversaw the study design, contributed to interpretations of the findings, and participated in writing the article. TK and MR provided background information and reviewed the literature. All authors have seen and approved the final version of the paper.

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A surprising impaired driving charge

Quebec police arrested a drunk driver who suddenly veered from one lane to the other, striking a car and seriously injuring the driver who had to be extracted using the ‘Jaws of Life’. So far, this story is too much like so many others to offer any surprises. There are, however, two twists to the story: the first is that the intoxicated driver was a Quebec police officer. He was charged with impaired driving causing bodily harm. The second? The drunken officer was driving a police car!

Are the Chinese good or careless drivers?

It seems that much depends on where in China you are: Beijing drivers behave differently than others, for example, where it is customary to ignore traffic lights entirely. Similarly, policing is variable but generally indifferent. http://en.radio86.com/lifestyle-china/dial-beijing/dial-beijing-public-transportation-safety-china