Non-fatal injuries resulting in activity limitations in Estonia—risk factors and association with the incidence of chronic conditions and quality of life: a retrospective study among the population aged 20–79

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ABSTRACT

Objectives: Evidence about the health and quality-of-life outcomes of injuries is obtained mainly from follow-up studies of surviving trauma patients; population-based studies are rarer, in particular for countries in Eastern Europe. This study examines the incidence, prevalence and social variation in non-fatal injuries resulting in activity limitations and outcomes of injuries in Estonia.

Design: A retrospective population-based study.

Setting: Estonia.

Participants: 7855 respondents of the face-to-face interviews of the second round of the Estonian Family and Fertility Survey conducted between 2004 and 2005 based on the nationally representative probability sample (n=11 192) of the resident population of Estonia aged 20–79.

Primary and secondary outcome measures: The cumulative incidence and prevalence of injuries leading to activity limitations was estimated. Survival models were applied to analyse variations in the injury risk across sociodemographic groups. The association between injuries and the development of chronic conditions and quality of life was examined using survival and logistic regression models.

Results: 10% (95% CI 9.4 to 10.7) of the population aged 20–79 had experienced injuries leading to activity limitations; the prevalence of activity limitations due to injuries was 4.4% (95% CI 3.9% to 4.9%). Significant differences in injury risk were associated with gender, education, employment, marital status and nativity. Limiting injury was associated with a doubling of the incidence of postinjury chronic conditions and quality of life in Estonia. The association of injury with the development of chronic conditions and reduced quality of life warrants further investigation.

Conclusions: Substantial variation in injury risk across population groups suggests potential for prevention. Men and workers in manual occupations constitute major target groups for injury prevention in Estonia. The association of injury with the development of chronic conditions and reduced quality of life warrants further investigation.
ARTICLE SUMMARY

Strengths and limitations of this study

- The main strength of this study lies on the nationally representative data of reasonable quality. The life-course approach allowed us to examine the association between injuries and outcomes over remarkably long periods.
- The limitations of this study arise first from selection bias related to the non-participation in the survey due to health reasons and the exclusion of those aged 80+. Besides, less severe injuries were not considered in our study. Therefore, we could underestimate the incidence and prevalence of incapaci-
ties due to injuries. Another limitation stems from recall bias, which leaves some injuries unreported; the retrospective mea-

Injuries cause a significant amount of human suffering. Worldwide, an estimated 5.8 million people die follow-
ing injury each year, thus injuries account for 10% of all
deaths. In Europe, injuries are the third most common
cause of mortality after cardiovascular diseases and
cancer; among children and the working-age population
below 45, they are the leading cause of death.

Until recently, epidemiologists used mortality statistics
when estimating the public health impact of injuries. Ac-

In addition to the immediate effects, injury victims are
at risk of persistent health and social problems. As fatality
rates of severe traumas are decreasing, at least in
countries with advanced healthcare systems, the study of
long-term outcomes has become an increasingly important
focus of contemporary injury research. This rapidly growing body of scientific evidence reveals a variety of influences encompassing physical and cogni-
tive functioning, social participation, productivity, psy-

Studies of patients with major trauma have shown that
significant effects often persist decades after injury. Even
mild injuries (eg, concussions) have been found to exert lasting influence on the victims. There is also evidence
that injuries cause secondary morbidity, for
instance psychiatric conditions after road accidents or
ocular disease after traumatic brain injury.

Routine data collection systems capture injury-related
deaths, hospital admissions and emergency department
visits but not the outcomes of injuries. The bulk of evi-
dence pertaining to the latter is derived from studies that
follow surviving patients and assess their condition at pre-
defined times after injury by means of self-report ques-
tionnaires or clinical examination. Although methodological details vary, such follow-up studies focus
on patient populations, defined according to the cause,
severity and other characteristics of their injuries. Coupled with marked variation in measurement tools
and generally small sample sizes, these features limit the
generalisability of such findings to other populations.

This article adds to the literature by reporting results of
a large population-based study conducted in Estonia
in 2004–2005. Like most countries of Central and
Eastern Europe, Estonia displays considerably greater
injury mortality than Western Europe. Although it has
been decreasing since the mid-1990s, the age-

The target population comprised men and women aged
20–79 at the beginning of 2004. The selection of cases
from the sampling frame (2000 census) was performed
using a single-stage random procedure. As is often found
in demographic surveys, women were oversampled. The
sample comprised 11 192 individuals. Fieldwork lasted

METHODS

Estonian Family and Fertility Survey

The data for this study came from the second round of
the Estonian Family and Fertility Survey (EFFS), carried
out in the context of the UNECE Generations and
Gender Programme. The survey collected retrospective
histories on life careers (family formation, childbearing,
education, work, residential mobility) and included a
health module.

The survey was based on a nationally representative
probability sample of the resident population of Estonia. The
target population comprised men and women aged
20–79 at the beginning of 2004. The selection of cases
from the sampling frame (2000 census) was performed
using a single-stage random procedure. As is often found
in demographic surveys, women were oversampled. The
sample comprised 11 192 individuals. Fieldwork lasted
from September 2004 until June 2005, with the bulk of interviews conducted in the latter year. Data were collected by a team of trained interviewers (n=120) via face-to-face interviews. Participation in the survey was voluntary, the response rate was 70.2%, being somewhat lower for men (65%) and younger respondents (65%). The weights introduced after the data collection correct for the oversampling of women and non-response. Additional information on the survey has been published elsewhere.24 25

**Measurements**

The health module focused on the assessment of conditions that limited the activities and social participation of the respondents over their life course. The presence of these conditions was ascertained by two questions: ‘Have you ever had any injuries that seriously limited your work, studies or daily activities for 3 months or longer?’ and ‘Have you ever had any long-term illnesses or health disorders that limited your work, studies or daily activities for 3 months or longer?’26

If the answer to either of the above questions was positive, several follow-up questions were asked concerning the characteristics of each reported injury and illness (cause, year and month of occurrence, duration of resulting activity limitation, medical certification of disability, etc). These retrospective questions provide a basis to estimate the cumulative incidence of injuries that led to activity limitations. The current prevalence of activity limitations resulting from injuries was judged from the follow-up question ‘Does this injury still limit your work, studies or daily activities today?’

The quality-of-life measures used in this study covered the following dimensions: (1) physical health (measured by self-rated health), (2) mental health (Mental Health Inventory-527), (3) family and social networks (Gierveld’s Loneliness Scale28), (4) material well-being (employment, poverty) and (5) subjective well-being (overall satisfaction with life and locus of control).

**Statistical methods and variables**

The analysis is structured in four parts. First, the occurrence of non-fatal injuries resulting in activity limitations is examined by means of descriptive measures (cumulative incidence and current prevalence by gender and age group). In all parts of the analysis, non-fatal injuries were self-defined as injuries that seriously limited the respondent’s work, studies or daily activities for 3 months or longer.

Second, survival analysis (Cox regression) is used to examine the sociodemographic risk factors associated with the incidence of activity-limiting injuries. The outcome variable is time (with monthly precision) elapsed from the birth of a respondent to first activity-limiting injury or censoring at the interview. Independent variables include gender, education, employment/activity status and marital status and place of residence, with age group as control variable.

Third, Cox regression is applied to analyse the impact of injuries on the development of chronic conditions (illnesses or health disorders) that limited respondent’s activity for 3 months or longer. The outcome variable is time from the birth of a respondent to the onset of first chronic condition or censoring at the interview. The main independent variable reflects the incidence of activity-limiting injuries and recovery from activity limitations; controls include gender, age group, education, employment/activity status, marital status and place of residence.

Fourth, to explore the association between injuries and quality of life, a series of logistic regression models is fitted. The outcome variables pertain to the different dimensions of quality of life described above. The independent variable reflects the incidence of injuries, with controls for sociodemographic variables.

The sociodemographic variables included in the models had previously been found to be significant correlates of health outcomes in various contexts, including Estonia.24 25 Modelling results are presented in terms of adjusted ORs (AORs) or adjusted HRs (AHRs), with 95% CIs associated with them. Further details pertaining to models and variables are given in the sections that follow. The analyses used weighted data that matches the age–gender structure of the resident population of Estonia. The SPSS statistical software (V.12.0.1) was employed for the analyses.

**RESULTS**

**Incidence and prevalence of injury**

Among the respondents, 10% reported injuries that led to activity limitation lasting at least 3 months. Of these, 8.7% experienced one injury, 1.1% two injuries and 0.2% three or more injuries.

The current prevalence of activity limitations related to injuries was 4.4%. This means that in Estonia about 1 in 20 adults aged 20–79 experiences some sort of activity limitation resulting from injury. Among the respondents who reported activity limitation due to injury, the mean duration of the condition was 18.3 years (median 12 years). To place these figures into perspective, the cumulative incidence of chronic conditions due to illness amounts to 26.8% and the prevalence of activity limitations due to the latter is 20.3%.

Table 1 reports the incidence of injuries and the prevalence of activity limitations due to injuries by gender and age group. Among men, both measures are about twice as high as for women. Across age groups, the cumulative incidence increases from 7.5% among 20-year-olds to 29-year-olds to 12.8% in the 60–69 age group. Similarly, the prevalence of injury-related limitations interfering with daily activities almost doubles, from 3% for people aged 20–29 to 5.8% among those aged 60–69. Among the 70–79 age group, the upward shift ceases but this result probably represents a selectivity bias rather than a true trend. This finding may also reflect a tendency of older people to attribute their
activity limitations to a chronic illness, rather than to an injury. Table 2 presents the AHRs of injury leading to activity limitations according to sociodemographic characteristics. The estimates from Cox regression models corroborate the strong association between the risk of injury and gender. Men have twice the chance of injury than women; the difference exceeds that observed for any other characteristic included in the analysis.

Higher education carried a 29% reduction in the risk of injury relative to the reference category (secondary education). Having basic education was not associated with significant excess risk compared with the reference category. Independent of education, employment in manual occupations relative to non-manual was associated with 54% higher risk of injury. Being a child/pupil/student was negatively associated with the risk of injury, but this difference was not statistically significant.

The residual employment/activity status carried a higher risk of injury but the difference from the reference category was not significant. Being divorced/separated was associated with a 43% increase in the risk of injury. Similarly, other non-married statuses were associated with higher risk but the difference from the reference category (married/cohabiting) was not statistically significant. According to our results, native respondents did not demonstrate better health outcomes: on the contrary, postwar immigrants and their descendants had about 40% lower risk of injury. The difference between urban and rural residents did not reach statistical significance.

**Association between injury and the development of chronic conditions**

Taking advantage of life history data, we modelled the change in the likelihood of developing a chronic illness in the period following injury. Our independent variable was time-varying and distinguished between three statuses: (1) the respondent had not experienced an activity-limiting injury (reference category), (2) the respondent had an injury currently causing activity limitations and (3) the respondent had suffered an injury but had recovered from activity limitations.

The results obtained from the Cox regression model reveal a significant increase in the chances of developing...
Association between injury and quality of life

The association between injury and quality of life was investigated by means of a series of logistic regression models (table 3). Model 1 presents a simple contrast between the respondents who experienced a limiting injury and those who reported no injuries (reference category). The result shows that injury is associated with the deterioration in all outcome measures, with the AORs from 1.22 (low life satisfaction) to 2.44 (poor self-related health). Except for life satisfaction, the estimates were statistically significant.

Model 2 adds a control for chronic illnesses that occurred beyond the context of injury; in essence, this additional control limits the reference group to respondents who never experienced injury or chronic illness. Not surprisingly, against that background the association with quality of life becomes more pronounced: the AORs range between 1.28 (low life satisfaction) and 4.15 (poor self-related health), with all estimates being statistically significant.

Model 3, developed from model 2, further elaborates the mechanism of how the association between injury and quality of life operates. Unlike in models 1 and 2, the independent variable has three levels in model 3: (1) the respondent had not experienced an activity-limiting injury or chronic illness (reference category), (2) the respondent had an injury currently causing activity limitations and (3) the respondent had suffered an injury but had recovered from activity limitations by the time of the survey. The result shows that injuries leading to activity limitations are indeed associated with a significant across-the-board deterioration in outcome measures, with AORs from 1.52 (low life satisfaction) to 7.32 (poor self-related health). However, the negative outcomes do not disappear with perceived recovery. Among the respondents who reported no longer suffer from limitations, four measures still indicate a significantly less favourable assessment of quality of life. In interpreting these results it is important to note that our quality-of-life measures were observed at the time of the survey. This prevented us from considering the temporal order of events in this part of analysis. As a result, it cannot be excluded that some of the quality-of-life characteristics preceded or even contributed to the injury. At the same time, given the systematic pattern reported in table 3, it seems unlikely that the observed associations are mainly produced by reverse causation.

Table 3  AORs (95% CIs) for low quality of life from logistic regression analysis, Estonian FFS 2004–2005

| QoL measure                        | Model 1                     | Model 2                     | Model 3                     |
|------------------------------------|-----------------------------|-----------------------------|------------------------------|
| Had injury                         | Had injury                  | Had injury, currently limited| Had injury, recovered        |
| Poor self-rated health (bad or very bad health) | 2.44 (1.98 to 3.00)         | 4.15 (3.29 to 5.22)         | 7.32 (5.46 to 9.81)          | 2.05 (1.45 to 2.89)          |
| High mental distress (MHI-5 score 0–56) | 1.85 (1.54 to 2.23)         | 2.02 (1.68 to 2.44)         | 2.41 (1.88 to 3.09)          | 1.72 (1.33 to 2.21)          |
| High loneliness (Gierveld’s score >8) | 1.72 (1.35 to 2.20)         | 1.81 (1.41 to 2.31)         | 2.47 (1.82 to 3.35)          | 1.22 (0.84 to 1.78)          |
| Non-employed                       | 1.69 (1.42 to 2.01)         | 1.80 (1.51 to 2.15)         | 2.84 (2.18 to 3.70)          | 1.28 (1.02 to 1.62)          |
| In poverty (<60% median hh income) | 1.49 (1.21 to 1.84)         | 1.55 (1.25 to 1.91)         | 1.57 (1.18 to 2.08)          | 1.53 (1.15 to 2.03)          |
| Low life satisfaction              | 1.22 (1.00 to 1.49)         | 1.28 (1.05 to 1.57)         | 1.52 (1.14 to 2.02)          | 1.11 (0.85 to 1.46)          |
| External locus of control          | 1.38 (1.10 to 1.73)         | 1.52 (1.21 to 1.91)         | 2.34 (1.77 to 3.11)          | 0.85 (0.58 to 1.23)          |

All models are adjusted for gender, age group, nativity, educational attainment, marital and employment status and place of residence. Models 2 and 3 include additional control for the incidence of chronic conditions beyond the context of injury (chronic condition occurred before injury or among persons who never experienced injury). All AORs compare with the reference category ‘never injured’. AOR, adjusted OR; FFS, Family and Fertility Survey; hh, household; MHI-5, Mental Health Inventory-5; QoL, quality of life.
in the study. Although the relationship becomes less pronounced over time, we found that significant differences in quality of life persist even after recovery from activity limitations.

**Consistency with previous studies**

Owing to differences in research design, instruments, etc., comparison of injury morbidity across studies is not an easy task. In the 2005 Health and Morbidity Survey in Denmark, a total of 2.3% respondents aged 16+ reported being seriously limited in their daily activities due to injuries. In the Oxford Healthy Lifestyle Study, 5% of the respondents aged 18–64 reported a long-standing disability as a result of injury. The US National Health Interview Survey reported that 3.5% of the non-institutionalised adult population experienced injury-related disability due to functional and sensory limitations. Although these figures may not be strictly comparable, they provide an order of magnitude estimate, which appears reasonably consistent with our findings. Our study also corroborates the WHO estimate according to which injuries account for about one-quarter of disabilities.

Social gradients in injury risks have been found in earlier studies in a number of different settings. Injuries disproportionately affect men, manual workers, people with low social status, and unmarried people. Our results are thus consistent in showing a systematic patterning of injuries across multiple sociodemographic dimensions. Perhaps contrary to expectations, we found no excess risk of injury among immigrants who are customarily regarded a vulnerable group in the country. The differential related to immigrants calls for additional research since the results exhibit noticeable variation across studies.

The development of postinjury chronic conditions has been reported in several studies but few of them have combined a life-course approach and large nationally representative samples. Although our study design does not permit strict causal inference, our results resemble those obtained from the British study of the 1958 birth cohort which revealed a doubling of the risk of limiting illnesses in the aftermath of injury (the study examined driver injuries occurring between ages 23 and 33 years). Our findings suggest the persistence of the excess risk of chronic conditions even after the reported recovery from injury-induced activity limitations. The same applies to adverse outcomes with regard to quality of life.

**Strengths and limitations**

The nationally representative data from the EFFS are considered to be of reasonable quality. Consistency checks and a low number of incomplete items do not indicate problems that could seriously bias the results. Compared with trauma patient studies, the population-wide coverage of the survey ensures the presence of all major strata of the population, including a comparison group (non-injured respondents). The collection of evidence directly from informants allows the inclusion of injuries and chronic conditions whether they were entered in medical records or not. The life-course approach allowed us to examine the association of injuries with the incidence of chronic conditions and quality of life over remarkably long periods and across several life domains. On the other hand, there are several methodological issues which may limit the validity of the reported results. Although the non-response rate in the EFFS does not exceed the level internationally observed in complex social surveys, some respondents (2.1%) were unable to participate because of health reasons. Therefore, the sample may have excluded people who were incapacitated due to injuries, resulting in an underestimation of incidence and prevalence. The exclusion of those aged 80+ could exert a similar influence since the risk of injuries increases in old age. Another limitation stems from recall bias, a common problem in retrospective surveys, which leaves some injuries unreported, particularly those with less severe consequences. Also, given the 3 months duration threshold applied in the survey, less severe injuries were not considered in our study. The retrospective measurement also involves selectivity bias as responses are obtained from survivors who are selected for better health; among others, this has likely contributed to the plateau of injury incidence observed in the 70–79 age group. Finally, a major limitation of the study is that the information on injuries is self-reported and not objectified by medical registration.

This said, we are inclined to think that the limitations of the study do not invalidate our main findings on the risk factors of injuries and on the association between injuries and the incidence of chronic conditions and the quality of life which appear statistically significant and robust with regard to model specification.

**Conclusions**

In terms of policy implications, our study draws attention to social variation in the risk of non-fatal injuries as well as to their long-term consequences. Significant differences in the injury risk across population groups point to opportunities for prevention and for reducing the currently high incidence of injury morbidity in Estonia. In particular, our results identify men and workers in manual occupations as major target groups for injury prevention in Estonia. Successful control of injury risks among these groups would substantially reduce the public health impact of injuries among the general population.

Our results suggest that injury is associated with an elevated risk of developing chronic conditions and lower quality of life in the period following injury. The limitations of our study leave unanswered the extent to which the observed associations reflect causal relationships. Conclusive evidence on the impact of injuries must be sought from prospective studies. Although large-scale prospective surveys based on nationally representative...
samples are rare, comparative surveys conducted in the framework of the SHARE (Survey of Health, Ageing and Retirement in Europe) programme offer a promising basis for further investigation.38

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Competing interests None.

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