

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 likelihood of having chronic conditions (adjusted HR 1.97, 95% CI 1.58 to 2.46). Injury exhibited a statistically significant negative association with most quality-of-life measures. Although reduced, these effects persisted after recovery from activity limitations.

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

ARTICLE SUMMARY

Article focus

- Non-fatal injuries are a major cause of disability and ill health among the population; social gradients in the risk of injury and the long-term consequences of injuries have been documented in a number of studies in middle-income and high-income countries.
- The bulk of evidence on the health and quality-of-life outcomes of injuries are obtained from follow-up studies of surviving trauma patients; population-based studies, which can offer useful additional insights, are rarer.
- The aim of current study was to improve understanding about the epidemiology of non-fatal injuries and their consequences for health and quality of life in Estonia, a country with the third highest rate of injury mortality in the EU-27.

Key messages

- This is a large-scale population-based study, applying a life-course approach that provided an opportunity to assess the social variation in the risk of non-fatal injury and its outcomes in Estonia.
- There is a noticeable variation in the risk of non-fatal injury, with significant differences associated with gender, education, employment, marital status and nativity.
- Injuries exhibit a positive association with the incidence of postinjury chronic conditions and with adverse quality of life outcomes; statistically significant association with injury persist even after reported recovery from injury-related activity limitations.

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 incapacities due to injuries. Another limitation stems from recall bias, which leaves some injuries unreported; the retrospective measurement also involves selectivity bias as responses are obtained from survivors who are selected for better health, in particular among older age groups. Finally, a major limitation of the study is that the information on injuries is self-reported and not objectified by medical registration.

INTRODUCTION

Injuries cause a significant amount of human suffering. Worldwide, an estimated 5.8 million people die following injury each year, thus injuries account for 10% of all deaths.¹ 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.²

Until recently, epidemiologists used mortality statistics when estimating the public health impact of injuries.^{3 4} According to contemporary views, however, deaths due to injuries represent only the tip of the iceberg. Although much less is known about the incidence of non-fatal injuries, it is estimated that for every fatality, 30 people will be hospitalised and 300 will require outpatient treatment.⁵ From an economic point of view, injuries incur significant costs to the health sector; for instance, in the EU-27 more than €15 billion is annually spent on direct medical costs treating injury casualties admitted to hospital.⁶

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.^{7 8} This rapidly growing body of scientific evidence reveals a variety of influences encompassing physical and cognitive functioning, social participation, productivity, psychological well-being, life satisfaction and quality of life.⁹ Studies of patients with major trauma have shown that significant effects often persist decades after injury.^{10 11} Even mild injuries (eg, concussions) have been found to exert lasting influence on the victims.¹² There is also evidence that injuries cause secondary morbidity, for instance psychiatric conditions after road accidents or ocular disease after traumatic brain injury.^{13 14}

Routine data collection systems capture injury-related deaths, hospital admissions and emergency department visits but not the outcomes of injuries. The bulk of evidence 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 questionnaires or clinical examination.^{9 15} 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.^{16 17}

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.¹⁸ Although it has been decreasing since the mid-1990s, the age-standardised mortality rate for injury in Estonia exceeds the average of the European Union 2.4 times (2010), with only Latvia and Lithuania being in a worse situation.¹⁹ Despite very high mortality and morbidity due to injuries, a search in PubMed reveals that existing research is limited to specific types of injury or small subgroups of the population.^{20–22} This renders the present study the first in Estonia to address the incidence and outcomes of non-fatal injuries among the general population.

The overall aim of this study is to improve understanding about the epidemiology of non-fatal injuries and their consequences for health and quality of life. The specific objectives are: (1) to estimate the incidence and prevalence of injuries resulting in activity limitations, and the sociodemographic risk factors associated with them, (2) to assess the role of injuries as a risk factor on the development of chronic conditions and (3) to explore the association between injuries and quality of life in the Estonian population.

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.²³ 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

Table 1 Number of respondents and injuries resulting in activity limitation, cumulative incidence of activity-limiting injuries and prevalence of activity limitations due to injuries by gender and age group, Estonian Family and Fertility Survey 2004–2005

	Number of			Cumulative incidence of injuries, % (95% CI)	Prevalence of activity limitations due to injuries, % (95% CI)
	Respondents	All injuries	First injuries		
Total	7855	913	789	10.0 (9.4 to 10.7)	4.4 (3.9 to 4.9)
Men	3560	575	493	13.8 (12.7 to 15.0)	6.1 (5.3 to 6.9)
Women	4295	338	296	6.9 (6.1 to 7.7)	3.0 (2.5 to 3.5)
20–29	1386	114	104	7.5 (6.1 to 8.9)	3.0 (2.1 to 3.9)
30–39	1449	146	121	8.4 (6.9 to 9.8)	3.9 (2.9 to 4.9)
40–49	1550	182	152	9.8 (8.3 to 11.3)	4.0 (3.0 to 5.0)
50–59	1349	159	144	10.7 (9.0 to 12.4)	4.9 (3.7 to 6.1)
60–69	1170	177	150	12.8 (10.9 to 14.8)	5.8 (4.4 to 7.2)
70–79	951	135	118	12.4 (10.3 to 14.5)	5.6 (4.1 to 7.1)

Sociodemographic risk factors of injury.

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

Table 2 AHRs (95% CIs) for first injury resulting in activity limitations from Cox regression analysis by sociodemographic characteristics, Estonian FFS 2004–2005

Characteristic	AHR	95% CI
Gender		
Men	2.02	1.73 to 2.36
Women	1	
Education		
Basic	0.98	0.81 to 1.19
Secondary	1	
Higher	0.71	0.51 to 0.98
Employment/activity status		
Child/pupil/student	0.72	0.49 to 1.06
Employed: manual work	1.54	1.24 to 1.91
Employed: non-manual work	1	
Other	1.19	0.90 to 1.57
Marital status		
Never-partnered	1.19	0.91 to 1.55
Married/cohabiting	1	
Divorced/separated	1.43	1.09 to 1.87
Widow(er)	1.09	0.71 to 1.66
Nativity		
Native	1	
Foreign origin	0.60	0.50 to 0.72
Place of residence		
Urban	1	
Rural	1.12	0.95 to 1.31

The model was also adjusted for age group. Nativity here distinguishes between the native population of Estonia (mainly ethnic Estonians) and the foreign-origin population (postwar immigrants from various parts of the former Soviet Union and their descendants). AHR, adjusted HR; FFS, Family and Fertility Survey.

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

a chronic condition in the period following injury. Controlling for potential confounding factors, the occurrence of a limiting injury was associated with a doubling of the risk of a chronic condition (AHR 1.97, 95% CI 1.58 to 2.46). Although reduced in scale, the statistically significant association persisted even after the recovery from injury-related activity limitations (AHR 1.37, 95% CI 1.10 to 1.70).

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 reportedly 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.

DISCUSSION

Principal findings

To our knowledge, this is the first large-scale population-based study applying the life-course approach to non-fatal injuries in Estonia. In the survey population aged 20–79, we found a cumulative incidence of activity-limiting injuries of 10%; the prevalence of activity limitations due to injuries was 4.4%. The mean duration of injury-related limitations observed at the interview was 18.3 years (median 12 years). Survival analysis revealed a noticeable variation in the risk of injury among different sectors of the population, with significant differences associated with gender, education, employment/activity status, marital status and nativity. Our results indicate a statistically significant positive relationship between injury and the development of chronic conditions: controlling for confounding factors, the occurrence of an activity-limiting injury was associated with a doubling of the likelihood of chronic conditions in the period following injury. Injury was also associated with a significantly lower quality of life in most dimensions examined

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.²⁹ In the Oxford Healthy Lifestyle Study, 5% of the respondents aged 18–64 reported a long-standing disability as a result of injury.³⁰ The US National Health Interview Survey reported that 3.3% of the non-institutionalised adult population experienced injury-related disability due to functional and sensory limitations.³¹ 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.³²

Social gradients in injury risks have been found in earlier studies in a number of different settings. Injuries disproportionately affect men,^{2 18 29} manual workers,^{30 33} people with low social status^{5 18} and unmarried people.³⁴ 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.^{21 25 35} 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).¹⁷ 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,³⁶ 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.⁵ Another limitation stems from recall bias, a common problem in retrospective surveys, which leaves some injuries unreported, particularly those with less severe consequences.³⁷ 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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REFERENCES

- World Health Organisation. *Injuries and violence: the facts*. http://www.who.int/violence_injury_prevention/key_facts/VIP_key_facts.pdf (accessed 8 Dec 2012).
- World Health Organisation. *World report on violence and health*. Geneva: World Health Organization, 2002. http://www.who.int/violence_injury_prevention/violence/world_report/en/ (accessed 4 Dec 2012).
- Gordon JE. The epidemiology of accidents. *Am J Public Health Nations Health* 1949;39:504–15.
- Bull JP. Measures of severity of injury. *Injury* 1978;9:184–7.
- Holder Y, Peden M, Krug E, et al. eds. *Injury surveillance guidelines*. Geneva: World Health Organization, 2001. <http://whqlibdoc.who.int/publications/2001/9241591331.pdf> (accessed 1 Dec 2012).
- Eurosafe. *Injuries in the European Union—Statistics summary 2005–2007*. [http://www.eurosafe.eu.com/csi/eurosafe2006.nsf/0/2DD3B414D49544AEC1257686004E6EBC/\\$file/2009-IDB-Report.pdf](http://www.eurosafe.eu.com/csi/eurosafe2006.nsf/0/2DD3B414D49544AEC1257686004E6EBC/$file/2009-IDB-Report.pdf) (accessed 7 Nov 2012).
- MacKenzie EJ. Epidemiology of injuries: current trends and future challenges. *Epidemiol Rev* 2000;22:112–18.
- Polinder S, Haagsma JA, Lyons RA, et al. Measuring the population burden of fatal and nonfatal injury. *Epidemiol Rev* 2012;34:17–31.
- Halcomb E, Daly J, Davidson P, et al. Life beyond severe traumatic injury: an integrative review of literature. *Aust Crit Care* 2005;18:17–18, 20–4.
- Anderson V, Brown S, Newitt H, et al. Long-term outcome from childhood traumatic brain injury: intellectual ability, personality, and quality of life. *Neuropsychology* 2011;25:176–84.
- Anđelic N, Hammergren N, Bautz-Holter E, et al. Functional outcome and health-related quality of life 10 years after moderate-to-severe traumatic brain injury. *Acta Neurol Scand* 2009;120:16–23.
- Ryan LM, Warden DL. Post concussion syndrome. *Int Rev Psychiatry* 2003;15:310–16.
- Haagsma J, Polinder S, Toet H, et al. Beyond the neglect of psychological consequences: posttraumatic stress disorder increases the non-fatal burden of injury by more than 50%. *Inj Prev* 2011;17:21–6.
- Rutner D, Kapoor N, Ciuffreda KJ, et al. Occurrence of ocular disease in traumatic brain injury in a selected sample: a retrospective analysis. *Brain Inj* 2006;20:1079–86.
- Ameratunga SN, Norton RN, Bennet DA, et al. Risk of disability due to car crashes: a review of the literature and methodological issues. *Injury* 2004;35:1116–27.
- Willemse-van Son AHP, Ribbers GM, Hop WCJ, et al. Community integration following moderate to severe traumatic brain injury: a longitudinal investigation. *J Rehabil Med* 2009;41:521–7.
- Li L, Roberts I, Power C. Physical and psychological effects of injury. Data from the 1958 British birth cohort study. *Eur J Public Health* 2001;11:81–3.
- Lai T, Köhler K, Roováli L. *Injuries in Estonia*. Series of the Ministry of Social Affairs. 2009;1. http://www.sm.ee/fileadmin/meedia/Dokumendid/V2ljaanded/Toimetised/2009/series_20095eng.pdf (accessed 18 Nov 2012).
- World Health Organization. *European Health for All Database*. <http://data.euro.who.int/hfad/> (accessed 7 Nov 2012).
- Sabre L, Pedai G, Rekand T, et al. High incidence of traumatic spinal cord injury in Estonia. *Spinal Cord* 2012;50:755–9.
- Tiikkaja S, Rahu K, Koupi I, et al. Maternal social characteristics and mortality from injuries among infants and toddlers in Estonia. *J Epidemiol Community Health* 2009;63:633–8.
- Tomberg T, Toomela A, Ennok M, et al. Changes in coping strategies, social support, optimism and health-related quality of life following traumatic brain injury: a longitudinal study. *Brain Inj* 2007;21:479–88.
- United Nations Economic Commission for Europe, Population Activities Unit. *Generations and Gender Programme*. <http://www.unece.org/pau/ggp/Welcomes.html> (accessed 27 Nov 2012).
- Katus K, Puur A, Pöldma A. *Estonian family and fertility survey, second round: standard tabulations*. RU Series C, 26. Tallinn: Estonian Interuniversity Population Research Centre, 2008.
- Altmets K, Puur A, Uusküla A, et al. Self-reported activity limitations among the population aged 20–79 in Estonia: a cross-sectional study. *Eur J Public Health* 2011;21:49–55.
- Estonian FFS Working Group. *Estonian family and fertility survey. Methodology and survey instruments. Interviewer's guide*. Tallinn: Estonian Demographic Association, 2004.
- Veit CT, Ware JE Jr. The structure of psychological distress and well-being in general populations. *J Consult Clin Psychol* 1983;51:730–42.
- De Jong-Gierveld J, van Tilburg T. A 6-item scale for overall, emotional and social loneliness. Confirmatory tests on survey data. *Res Aging* 2006;28:582–98.
- Laursen B, Möller H. Long-term health effects of unintentional injuries in Danish adults. *Dan Med J* 2012;59:A4423, 1–4.
- Plugge E, Stewart-Brown S, Knight M, et al. Injury morbidity in 18–64-years olds: impact and risk factors. *J Public Health* 2002;24:27–33.
- Shults RA, Jones BH, Kresnow M, et al. Disability among adults injured in motor-vehicle crashes in the United States. *J Safety Res* 2004;35:447–52.
- World Health Organization. *Disability and rehabilitation*. Geneva: World Health Organization. http://www.who.int/violence_injury_prevention/disability/en/ (accessed 27 Nov 2012).
- Hannerz H, Mikkelsen KL, Nielsen ML, et al. Social inequalities in injury occurrence and in disability retirement attributable to injuries: a 5 year follow-up study of a 2.1 million gainfully employed people. *BMC Public Health* 2007;7:215.
- Vikhireva O, Pikhart H, Pajak A, et al. Non-fatal injuries in three Central and Eastern European urban population samples: the HAPIEE study. *Eur J Public Health* 2009;20:695–701.
- Sakkeus L, Karelson K. The health transition in Estonia: breaking away from the Soviet legacy. In: Nazrul H, Swanson D. eds. *Opportunities and challenges for applied demography in the 21st century*. Dordrecht: Springer, 2012:227–62.
- De Heer W. International response trends: results of an International Survey. *J Official Stat* 1999;15:129–41.
- Moshiro C, Heuch I, Åhström AN, et al. Effect of recall bias on non-fatal injury rates: a community-based study in Tanzania. *Inj Prev* 2005;11:48–52.
- SHARE. *Survey of Health, Ageing and Retirement in Europe*. <http://www.share-project.org/> (accessed 20 Apr 2013).