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Road traffic crashes in Arkhangelsk, Russia in 2005-2010

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The process resulting in this doctoral dissertation started nine years ago. Since then I have been fortunate to meet several remarkable persons who have trained, inspired, supported, advised, and guided me in the different stages to finally presenting this thesis.

It all started in 2003 when I was a last year student of the Faculty of Clinical Psychology at the Northern State Medical University (NSMU) in Arkhangelsk, Russia. I was invited to the office of the vice-rector for international affairs Andrej Soloviev who suggested that I should apply for master training in Public Health at Umeå University, Sweden. The application was a success and changed my life. Therefore, I will always gratefully associate Andrej Soloviev with my first step into the public health field. De facto, my candidature for the master training was suggested by the rector of NSMU Pavel Sidorov. He told me before I left for Sweden: 'Do not make the master degree your final target. Make sure it is only a step towards your PhD'. This was the first time I thought of an international doctoral degree. I wish to express my great thanks to Pavel Sidorov for 'sowing the seed' of a scientific career into my mind as well as for consistent pushing me forward in my scientific work.

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Alexander Kudryavtsev

Tromsø, October 2012

LIST OF PAPERS

The thesis is based on the following papers which are further referred by their Roman numerals:

I. Kudryavtsev AV, Lund J, Nilssen O, Grjibovski AM, Ytterstad B. **Road traffic crashes with fatal and non-fatal injuries in Arkhangelsk, Russia in 2005-2010.** Accepted for publication in the Int J Inj Contr Saf Promot on 11 October 2012.

II. Kudryavtsev AV, Kleshchinov N, Ermolina M, Lund J, Grjibovski AM, Nilssen O, Ytterstad B. **Road traffic fatalities in Arkhangelsk, Russia in 2005-2010: reliability of police and healthcare data.** Revised version is submitted to the Accid Anal Prev on 30 September 2012.

III. Kudryavtsev AV, Nilssen O, Lund J, Grjibovski AM, Ytterstad B. **Explaining reduction of pedestrian-motor vehicle crashes in Arkhangelsk, Russia, in 2005-2010.** Int J Circumpolar Health 2012, 71: 19107.[a]

IV. Kudryavtsev AV, Nilssen O, Sumarokov Y, Ytterstad B. **Injury Prevention and Safety Promotion course in a Russian Master of Public Health programme.** Int J Inj Contr Saf Promot. 2012 Sep;19(3):290-6.[b]

LIST OF DEFINITIONS

Crash (road traffic accident) – an event that occurred on a road, involved a vehicle (motorized or animal-drawn) in motion, and resulted in a human injury, fatality or material damages (1).

Traffic fatality (police definition) – an injury resulting from a crash and causing death within 30 days (1). The 30-days fatality definition was adopted by the Russian road police in 2009. Previously, a 7-days fatality definition was used by the police (2).

Traffic fatality (healthcare definition) – any death for which a road traffic crash is the underlying cause regardless of the length of time that elapses between the crash and the time of death; ICD-10 codes V02-04, V09, V12-14, V19, V20-79, or V86-89 (3).

Non-fatal traffic injury – a bodily injury resulting from a crash and leading to at least twenty-four hours of hospitalization, or requiring out-patient treatment (1).

Pedestrian-motor vehicle crash – an event on a road where a motorized vehicle in motion collided with a pedestrian, resulting in an injury.

LIST OF ABBREVIATIONS

APC – average percent change

CI – confidence interval

DAI – data accuracy index

DALY – disability-adjusted life year

ECTS - European Credit Transfer System

ICD-10 – International Classification of Diseases, 10th revision

ISPHA – International School of Public Health, Arkhangelsk

MPH – Master of Public Health

NBR - negative binomial regression

NSMU – Northern State Medical University (Arkhangelsk)

RUB - Russian rouble

WHO – World Health Organization

ZINBR - zero-inflated negative binomial regression

1. INTRODUCTION

1.1. Global burden of road traffic deaths and injuries

Road traffic crashes are a major public health problem around the world causing globally over 1.2 million deaths per year (4). World Health Organization (WHO) has projected that the number of traffic deaths will increase up to 2.4 million in 2030 and this will move traffic crashes from the ninth leading cause of death in the world in 2004 to the fifth in 2030 (5).

The road traffic mortality is only a ‘top of the iceberg’ of the total losses of human and societal resources from traffic crashes. WHO estimates that 20-50 million people are injured or disabled each year in traffic crashes worldwide (6). In 2004 traffic crashes accounted for 41.2 millions of disability-adjusted life years (DALYs) in the world population (2.7% of total DALYs) and were ranked the ninth leading cause of burden of disease globally (5). According to WHO projections for 2030, traffic crashes will become the third leading cause of burden of disease in the world and account for 4.9% of total DALYs (5).

The magnitude of the traffic crash problem varies between countries with the heaviest burden being carried by low and middle income countries (4). The problem is expected to grow most in these countries due to economic growth and increasing motor vehicle ownership (5).

1.2. Road traffic crashes, injuries and deaths in the Russian Federation

According to the European Status Report on Road Safety, Russia has the second highest traffic mortality in the WHO European region (Fig 1.) (7). Compared to its Northern neighbours – Finland, Sweden, and Norway – Russia's traffic mortality is more than triple (7).

In 2009-2011, annual numbers of traffic deaths and non-fatal injuries in Russia exceeded 26,000 and 250,000, respectively (8-11). Every third injury traffic crash in Russia leads to a killed or non-fatally injured pedestrian (10), and this is similar to the global situation (12, 13).

Being a major public health concern in Russia, the problem of traffic crashes is being addressed by the nationwide Road Safety Improvement Federal Target Programme 2006-2012 (14, 15). The goal of the programme is a 1.5-fold reduction in number of traffic deaths in Russia by 2012, compared to 2004 (14). To achieve this goal, five key traffic safety measures are being implemented within the programme: (i) legislative tightening of administrative responsibility for traffic offenses and adoption of stricter vehicle safety standards; (ii) strengthening of traffic law enforcement by widespread introduction of modern means of police control; (iii) wide implementation of engineering solutions to improve traffic organization; (iv) media and educational campaigns to promote traffic safety, increase legal awareness of the population, and prevent risky behaviours; (v) improvement of the system of medical care to victims of traffic crashes (14).

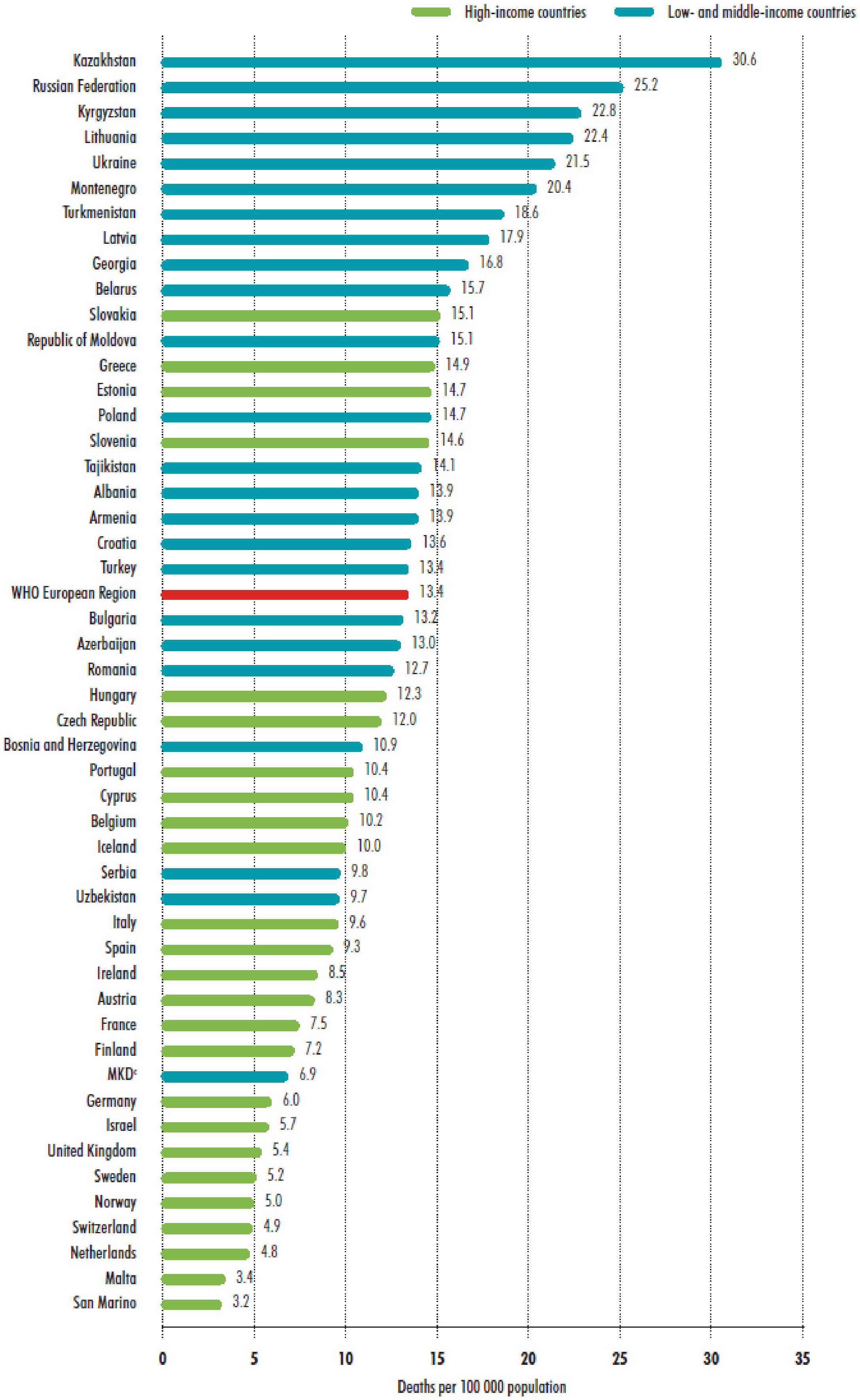

Figure 1. Road traffic mortality per 100,000 population, WHO European Region (WHO, 2009)

According to the national road safety statistics, implementation of the programme was associated with reductions in numbers of traffic crashes, fatalities and injuries (Fig. 2) (8-11, 16, 17). In relation to 100,000 of the total Russian population, traffic mortality rate decreased from 23.0 to 19.6 in 2006-2011, and the non-fatal traffic injury rate decreased from 200.3 to 176.2, respectively (11, 18, 19). Nevertheless, the road safety situation in the Russian Federation in 2011, compared to 2004, indicates that the measures implemented in the area of road safety do not achieve the desired goal of 1.5-fold reduction in the number of traffic deaths.

Being the world largest country in terms of territory, Russia has a large variation in climatic, socioeconomic, cultural, and many other aspects. Therefore, the aggregate Russian national statistics can mask regional variations and may not be adequately describing road safety situation and effects of road safety measures at specific local settings.

1.3. Assessment of the road safety situation in Russia

Continuous assessment of the road safety situation in Russia is based on the data collected by the State Traffic Safety Inspectorate of the Ministry of Internal Affairs (1).

The assessment of the situation and its changes is largely based on annual counts of traffic crashes, fatalities and non-fatal injuries. Distributions and dynamics in numbers crashes and casualties by subgroups are also commonly presented in annual road safety reports.

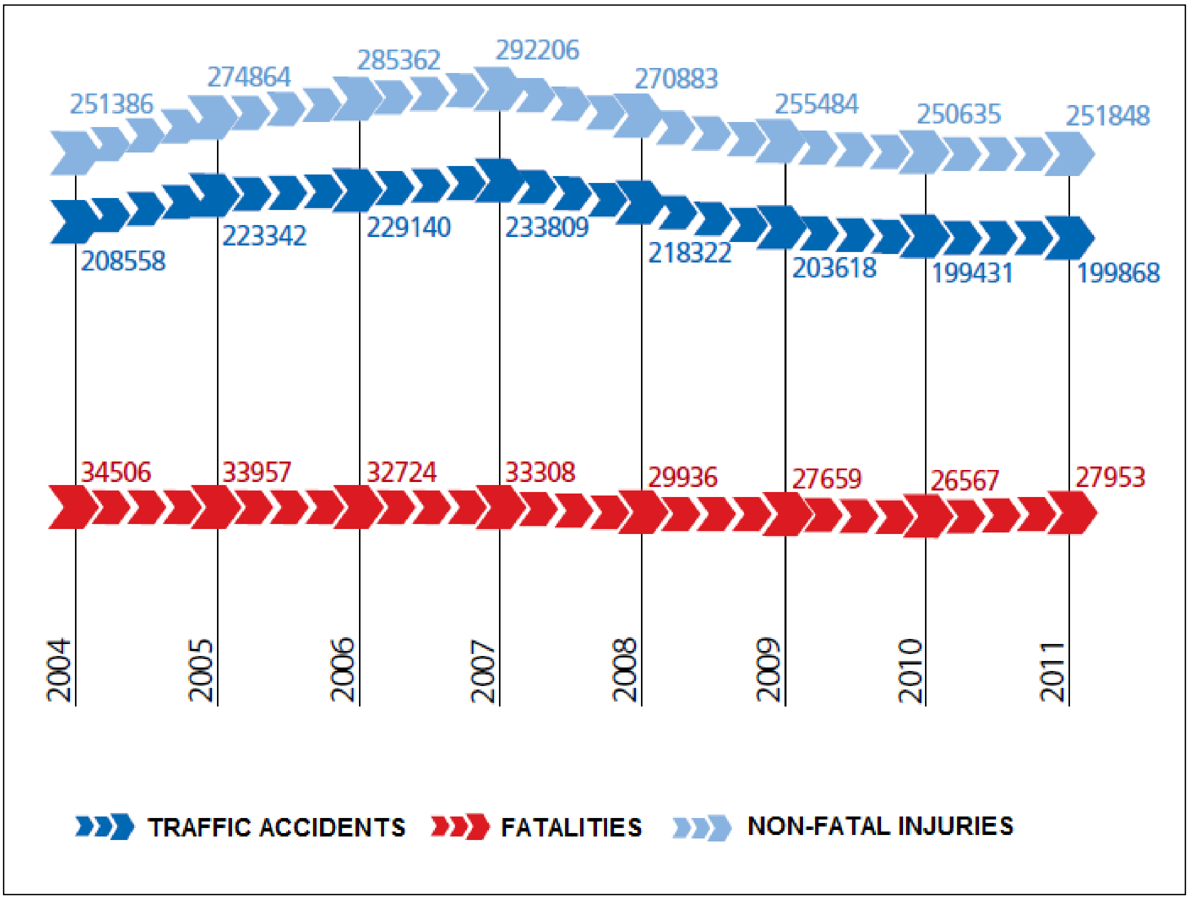

Figure 2. Traffic accident statistics for the roads of the Russian Federation up to 2011 (State Traffic Safety Inspectorate of the Ministry of Internal Affairs of Russia, 2012)

Aggregate relative indicators are also used for assessment of the road safety situation. These are: (i) 'transport risk' or rate of traffic crashes with fatal and non-fatal injuries per 10,000 motor vehicles; (ii) 'social risk' or traffic mortality rate per 100,000 of total population; and (iii) 'severity of consequences' or ratio of total traffic fatalities to total traffic casualties (8, 9, 16, 17). The same indicators are used as performance indicators of road safety interventions.

As it can be seen from Russian official sources (10, 11), judgments about changes in the traffic safety situation in the country are mostly being done on the basis of observed changes in the annual traffic safety indicators, although the observed changes are often small and can be attributed to random variation. The official conclusions about effects of the implemented traffic safety interventions are also commonly derived from the observed changes in the aggregate indicators. However, aside from the interventions the changes in these indicators can be due to random variation as well as due to measurement biases and confounding from a number of factors. Therefore, the official Russian reports on changes in the road safety situation and statements of the effects of interventions often seem lacking statistical evidence.

There is also a concern about the completeness and reliability deficits of Russian as well as other national data on traffic crashes, fatalities and injuries (4, 7, 20-25). These deficits may threaten the validity of local road safety assessments and bias international comparisons.

1.4. Motivation for the study

The motivation for the present work stems from a combination of my 14 years experience of driving in Arkhangelsk, 5-year experience of teaching epidemiology and statistics at the Northern State Medical University (Arkhangelsk), involvement as an administrator and teacher in the course Injury Prevention and Safety Promotion at the Arkhangelsk International School of Public Health, and inspiration by the metaphor ‘local data is the locomotive that keeps the injury prevention train on its track’ (26).

The present thesis is an attempt to utilize my knowledge in epidemiology and statistics and the routinely collected but only partially used police data for improved assessment of the traffic safety situation in Arkhangelsk.

All my studies were performed in tight cooperation with the Arkhangelsk road police. My hope is that this cooperation is fruitful for the police to better understand recent traffic safety developments in the city, improve regular practices of collecting, analyzing, and using data on the road safety issues, and increase efficiency of their valuable work.

2. AIMS OF THE THESIS

- To investigate trends in traffic crashes with fatal and non-fatal injuries in Arkhangelsk, Russia in 2005-2010 (Paper I)

- To estimate and compare reliability of traffic mortality data of the police and the healthcare sector in Arkhangelsk, Russia in 2005-2010 (Paper II)

- To try to explain a downward trend in pedestrian-motor vehicle crashes that was observed in Arkhangelsk, Russia in 2005-2010 (Paper III)

- To describe the experience of disseminating the science-based approaches to injury prevention and safety promotion by including a course ‘Injury Prevention and Safety Promotion’ into the Master of Public Health programme in Arkhangelsk (Paper IV)

3. MATERIALS AND METHODS

3.1. Study design

The thesis consists of four interrelated parts that are based on different retrospective study designs. It starts from a descriptive study of trends in rate data over a time period (Paper I). The second part is the data reliability study where two data sources data are verified against each other (Papers II). The third part is an ecological study of associations between outcome rates and potential explanatory variables (Paper III). The fourth part is a description and evaluation of a public health capacity building project (Paper IV).

In other words, our retrospective studies started from investigation of trends in outcomes (crashes, fatalities, non-fatal injuries) that was to answer the questions: 'Were there changes in the road safety situation?', 'What was the major change?', or simply 'What has happened in that period with respect to road safety?' (Paper I) (Fig. 3). In order to be able to defend validity of our conclusions regarding the trends, we performed a study to assess reliability of our data sources (Paper II). Thereafter we looked into the past exposures and interventions in order to identify the determinants of the major trend in the road safety situation and answer the question 'What caused the observed major change?', or simply 'Why has it happened?' (Paper III). Doctoral studies of the author were going in parallel with administration and teaching of the course 'Injury Prevention and Safety Promotion' within international capacity building project, so the fourth paper emerged as a description of this parallel experience (Paper IV). It was to answer the questions 'How can the research-based knowledge on injury prevention and safety promotion be disseminated?' and 'Is there a demand for it in the Northwestern Russia?'

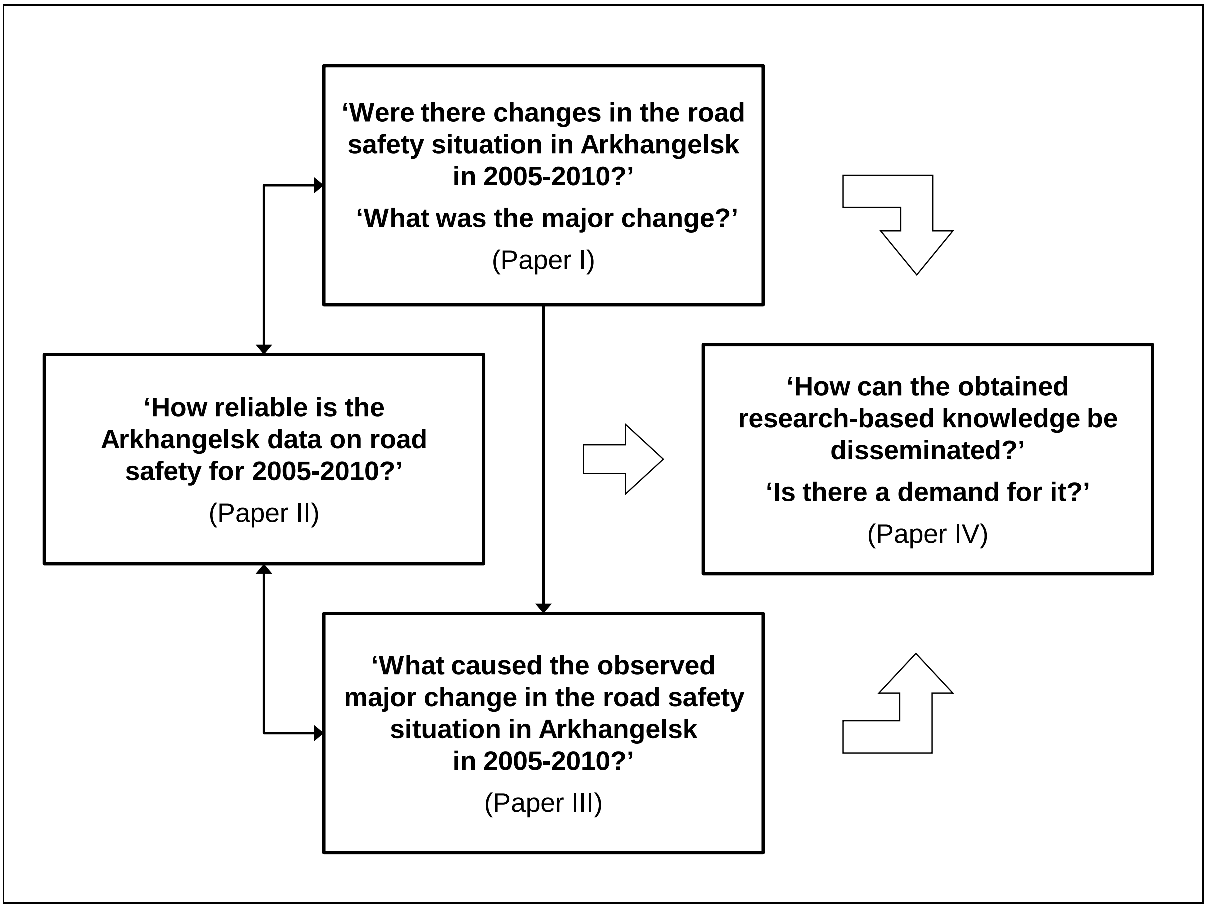

Figure 3. Structure of the thesis

3.2. Study setting and period

The study was performed in the Arkhangelsk city and covered a 6-year period from 1 January 2005 to 31 December 2010.

Arkhangelsk is situated in the Northwestern part of Russia and is included into to the Barents Euro-Arctic Region – Europe's northernmost and largest region for interregional cooperation (Fig.4) (27). It is an administrative, industrial, educational, and cultural centre of the Arkhangelsk region. The total city area covers 334 square kilometres and stretches 35 kilometres along the banks of the Northern Dvina River. The total residential population of Arkhangelsk was 357,733 at the baseline of the study and decreased to 355,556 at the end-point (0.6% reduction).

Figure 4. Map of the Barents Euro-Arctic Region (BarentsInfo.org)

3.3. Data sources and description

To achieve the aims of the thesis, multiple sources of data were used: (i) the State Traffic Safety Inspectorate of the Ministry of Internal Affairs, later called the *police*; (ii) the Regional Medical Informational Analytic Centre of the Ministry of Health and Social Development of the Arkhangelsk region, later called the *healthcare statistics centre*; (iii) the Department for Road Safety of the Arkhangelsk Major’s Office, later called the *road safety department*; (iv) national legislative acts; (v) administration of the International School of Public Health, Arkhangelsk (ISPHA) of the Northern State Medical University (Arkhangelsk).

Police data

The Arkhangelsk road police are responsible for assessment and control of traffic safety in the Arkhangelsk city area. For this reason, the police have several databases that collect and contain data on road traffic issues.

The data on all registered crashes with fatal and non-fatal injuries are recorded into a special computerized police database. The registration of crashes and related casualties in the database is linked *to places and dates of crashes.* The data is fed into the database from standardized police crash report forms that contain information about crash time and site, circumstances, vehicles involved, personal and demographic data on involved individuals and their health outcomes (Appendix). Filling in these forms by policemen starts on crash sites. The data on health outcomes are verified by the hospital data 30 days after crashes. Approximately 90% of the forms are completed by this time. The completion of the rest of the forms takes up to one year, depending on the complexity of required court proceedings. The police database of crashes with fatal and non-fatal injuries serves a basis for routine road safety assessment and reports.

According to the national rules for accounting of traffic crashes and casualties, hospitals are obliged to report all traffic fatalities and non-fatal injuries to the police, and the hospital information about the cases is required to be added to the police database (1). In addition, every crash, with or without personal injuries, is subjected to investigation of legal issues by the police before the vehicle owners can apply for insurance refund of damages. This system assures a high coverage of the traffic crashes by the police registration.

The Arkhangelsk police also hold four other separate databases: the database of all registered crashes (with or without personal injuries), the database of registered motor vehicles, the database of holders of driving licenses, and the database of traffic offences. These databases have no functional links with each other and their use is almost entirely limited to definite administrative purposes. Only some aggregate figures from these databases are utilized for road safety assessment and reporting (for example, total annual number of traffic crashes, number of registered motor vehicles at the start of a year, annual number of registered cases of driving under influence of alcohol).

For the purposes of our studies (Papers I-III), the police provided data on all crashes with fatal and non-fatal injuries registered during 2005-2010. One crash may involve several vehicles and individuals (injured and not injured). For that reason, a record (a row) in the police database contains information on one individual crash participant. For every crash participant (both injured and not injured) the available variables were: date of crash (day, month, year), time (hour, minute), registration number of the crash in the police database (numeration is restarted every year), type of crash (collision, fixed object crash, stationary vehicle crash, rollover, bicyclist crash, pedestrian-motor vehicle crash, other road crash), date of birth (day, month, year), gender (male, female), health outcome (fatality, injury, not injured), road user type (driver, passenger, pedestrian, other), type of motor vehicle (27 types), and registered traffic violations (50 types). The structure of the data allowed using it for studies regarding crash participants and their health outcomes as well as for studies regarding crashes as events. For the purposes of the data reliability study (Paper II), additional variables were obtained for each traffic fatality case: place of crash (name of street, number of building) and place of residence (name of city or other settlement). To better explain reduction in pedestrian-motor vehicle crashes (Paper III), data on type of crash site (signalized crosswalk at junction or span, non-signalized crosswalk at junction or span, and junction or span with no crosswalk) was additionally obtained for each pedestrian-motor vehicle crash.

Apart from the described variables, the police provided data on all traffic offences that were registered in Arkhangelsk in the study period. For each traffic offence the available variables were date (day, month, year), type of traffic offence (135 types), type of penalty (oral warning, fine, withdrawal of driving license, imprisonment), and the amount of Russian roubles (RUB; 1 United States dollar ≈ 30 RUB) for a fine.

Finally, the police has provided aggregate data for the study period: monthly data on total number of crashes (including crashes with only vehicle damages), annual data on the total number of motor vehicles registered in the city (for 1 January of each year 2005-2011), and annual data on total length of the city road network.

According to the national legislation and internal police regulations, none of the provided police data variables on crashes, crash participants, and traffic offences contained information allowing identification of a person. Besides, by agreement with the police, only one non-employee of the police – the author of the thesis – had access to the provided raw data variables. Thesis supervisors and co-authors of the papers accessed only aggregated data.

Healthcare data

The Arkhangelsk regional healthcare statistics centre is responsible for collecting, analysis and reporting of data on medical services in the Arkhangelsk region. The key task of the centre is a routine collection and processing of standardized medical reports from hospitals and other healthcare institutions (general practitioners, primary health care units, out-patient clinics, emergency ambulance services, delivery houses, and morgues). Reports are collected on all cases of birth, death, disease, and injury in the residential population of the region and among temporary visitors. The mortality, morbidity and injury data are coded using the International Classification of Diseases, 10th revision (ICD-10) (3) and are fed into regional mortality and morbidity databases (registers). In contrast with the police registration of traffic casualties (that is linked *to places and dates of crashes*), registration of traffic casualties in the healthcare registers is linked *to places and dates of seeking medical care or deaths*. Notably, registration of traffic fatalities in the mortality register is based on pathologists' diagnoses of underlying causes of deaths and is not tied to numbers of days between crashes and deaths (3). Therefore, the international 30-day traffic mortality definition is not followed, and the register also includes cases of death 30 days after crashes. The mortality and morbidity registers of the healthcare statistics centre are used for assessments of the population health. These are presented in annual reports on demography, mortality and morbidity in the region.

The healthcare statistics centre participated in our study on reliability of traffic mortality data (Paper II). The mortality register of the centre was the source of the healthcare data on all traffic fatalities in the city over 2005-2010 (ICD-10 codes V02-04, V09, V12-14, V19, V20-79, and V86-89). For each case, the provided data included: date of birth (day, month, year), date of injury (day, month, year), date of death (day, month, year), hospital of death (where applicable), ICD-10 code (containing information on road user type and type of vehicle), gender, and place of residence (name of city or other settlement). None of the provided healthcare data variables contained information allowing identification of a person.

Data on total population of the Arkhangelsk city on 1 January of every year 2005-2011 were also obtained from the healthcare statistics centre.

Interrelations between police and healthcare data

The police and healthcare data on traffic fatalities and injuries are linked by legislatively mandated rules of collecting data on traffic casualties (1). As mentioned above, these rules oblige hospitals to report all fatal and non-fatal traffic injuries to the police and authorize the police to verify their data on registered cases against the data of hospitals and other healthcare institutions. This legally mandated verification of the police versus the healthcare data facilitated our study on reliability of the Arkhangelsk traffic mortality data (Paper II). According to legal restrictions, the verification procedure was performed exclusively by authorized employees of the police and the healthcare statistics centre. It involved matching of fatality cases in the two data sources by names (first, middle, last) and several other variables. The personal identifying variables were removed from all case records after the matching procedures. Therefore, personally identifying information of traffic fatality cases were used for the purposes of this thesis, but it was not accessible for the author.

Data of road safety department

The road safety department of the Arkhangelsk major's office is responsible for maintaining and improving safety of the city road network. Therefore, all infrastructure road safety measures (for example, installation of traffic signals, maintaining of road markings) are being introduced in the Arkhangelsk city via this department. The department functions in tight connection with the road police as the police data serves a basis for decisions regarding the needs for infrastructural road safety solutions in the city.

For the purposes of our study attempting to explain the reduction of pedestrian-motor vehicle crashes (Paper III), the road safety department provided information on changes in characteristics and numbers of non-signalized and signalized pedestrian crosswalks in Arkhangelsk in 2005-2010: establishment of new signalized and non-signalized crosswalks as well as installations of speed humps and light-reflecting vertical traffic signs with fluorescent yellow-green outer frames at non-signalized crosswalks. For all these infrastructure measures addresses (street, closest building) and dates (month, year) were obtained.

Data from national legislative acts

National legislative acts of the Russian Federation were used as a source of data on legislative measures to improve pedestrian safety on the country level in the study period (Paper III). The legislative acts were accessed by reviewing the 'news' and the 'normative documents' sections of the official web-site of the State Traffic Safety

Inspectorate of the Ministry of Internal Affairs of Russia (http://www.gibdd.ru/) for the study period.

The relevant legislative measures were increases in fines for pedestrian-crash-related traffic offences: (i) driver failure to give way to pedestrian on a non-signalized crosswalk, (ii) ignoring prohibiting traffic signal by a driver (iii) ignoring prohibiting traffic signal at a signalized crosswalk, crossing outside crosswalk, and walking on road by a pedestrian. For each fine increase, date (day, month, year) and size ('from-to') in RUB was obtained.

Administrative records and archives of the school of public health

The ISHPA was established at the NSMU in Arkhangelsk in 2006 due to initiative of the Department of Community Medicine of the University of Tromsø and with financial support from the Barents Health Programme. Besides the University of Tromsø and the NSMU, five other educational and research institutions of the Northern Europe participated in 'the ISPHA project': Nordic School of Public Health (Sweden), Umeå International School of Public Health (Sweden), Mid-Sweden University (Sweden), Tampere School of Public Health (Finland), and National Institute of Public Health (Norway) (28, 29). Since 2007, the ISPHA offers international Master of Public Health (MPH) programme, 120 European Credit Transfer System (ECTS) points. Establishment of the school and the master training were meant to meet the needs of health professionals from the Northwestern Russia concerning public health issues. From 2007, the MPH curriculum at the ISPHA includes an elective course on Injury Prevention and Safety Promotion, 5 ECTS.

Administrative records and archives of the ISPHA for 2007-2012 were sources of information about the curriculum of the course on Injury Prevention and Safety Promotion, its students and teachers, training-the-trainers programme, evaluation procedure, and results of the evaluation (Paper IV). The obtained information included the course description (requirements, structure, contents, literature, teaching methods, teachers), student data (gender, previous education, and residence), description of the training-the-trainers programme (selection of trainees, structure and components of the programme, changes in distribution of teaching workload among teachers and trainees during 2007-2010), and data from student evaluation forms (visual analogue scales and open-ended questions).

3.4. Data presentation

The crash, fatality and non-fatal injury data are presented as annual and monthly count numbers, proportions, and rates per 100,000 of total Arkhangelsk population and per 10,000 registered motor vehicles (Papers I-III). To be used as denominators in calculations of the monthly rates, mid-month totals of motor vehicles and population in the city were estimated from annual data with assumption of linear monthly changes in these variables within each year.

By following recommendations of the Economic Commission for Europe and the European Conference of Ministers of Transport (30), the police's change from 7-day to 30-day traffic fatality definition in January 2009 (1, 2) was accounted for by applying the standardised 30-day traffic fatality adjustment factor of 1.08 to the count data on traffic fatalities for 2005-2008. The adjusted count numbers of traffic fatalities are presented together with the original numbers (Paper I).

The provided raw police variables on crashes, crash participants and traffic offences were subjected to restructuring and recoding for descriptive and analytic purposes. The variables 'road user type' and 'type of MV' were combined in a 'road user group' variable that divided all road users into 6 groups: 'drivers of motorized vehicles with four or more wheels', 'passengers of motorized vehicles with four or more wheels', 'motorcyclists' (including both riders and passengers), 'bicyclists', 'pedestrians' and 'others' (Papers I-III). Numbers of categories in several police variables were reduced by combining original categories into groups: (i) the variable 'type of traffic offence' (135 categories) was reconstructed into 'traffic offences by road user type' (drivers' offences, pedestrians' offences, and offences by other road users); (ii) the variable 'type of place' for a crash (signalized crosswalk at junction or span, non-signalized crosswalk at junction or span, and junction or span with no crosswalk) was reconstructed into 'crash site' (signalized crosswalk, non-signalized crosswalk, outside crosswalk) (Paper III).

The data on all registered drivers' traffic offenses in the study period were aggregated into monthly counts and are presented as monthly rates per 100 motor vehicles. These rates are taken as estimates of monthly percentage of drivers caught by the police on traffic offences. Similarly, the data on pedestrians' offenses are presented as monthly rates per 100 population, and these rates are taken as estimates of monthly percentage of total residents caught on traffic offences as pedestrians. The two rates are used as proxy measures for intensity of police enforcement regarding drivers and pedestrians in the study period (Paper III).

The data of the road safety department on infrastructure measures to improve pedestrian safety are presented as count variables with each value being a total number of specified infrastructural pedestrian safety units in the city in a month of the study period.

The data on legislative measures is presented as qualitative (categorical) ‘before-after’ variables with time references.

The information about the course on Injury Prevention and Safety Promotion at the ISPHA is largely presented in a form of qualitative description. The student distributions by gender, educational background and residence are presented as absolute numbers and proportions. The results of student evaluations on visual analogue scales are presented as means and ranges (minimum-maximum). The results of student evaluations by answering open-ended questions are presented as most common suggestions for course improvements.

3.5. Data analyses

Regression analyses

Data on crashes, fatalities and non-fatal injuries as well as on infrastructure, legislative and law enforcement pedestrian safety measures in the study period were analysed on monthly basis comprising 72 observations in each variable (Papers I, III). For investigation of time trends in monthly crash, fatality and non-fatal injury data negative binomial regression (NBR) and zero-inflated negative binomial regression (ZINBR) (31, 32) with time regressor variable were applied (Papers I, III). Similar analyses were performed to estimate associations between monthly occurrences of pedestrian-motor vehicle crashes and changes in various safety measure variables (Paper III).

The NBR is an extension to the Poisson regression that is applied for modelling discrete (count) outcome variables (32). The Poisson regression assumes that a count outcome variable is drawn from the Poisson distribution and is a function of observed independent variables. In other words, the Poisson regression accounts for so called *observed heterogeneity* in a count outcome variable – the heterogeneity that is explained by predictor variables (31). One more assumption of the Poisson regression is that an outcome variable has equal mean and variance (31-33). Compared to that, the NBR has an additional random error component that accounts for *unobserved heterogeneity* in a count outcome variable – the heterogeneity that is not explained by predictor variables. This allows for modelling count outcomes with greater than the Poisson variation and a variance larger than a mean. Accordingly, the NBR is preferable to the Poisson regression for modelling so called overdispersed count variables (31, 33, 34).

Given that overdispersion was a characteristic of the majority of our outcome variables, we preferred the NBR to the Poisson regression in all analyses. This decision was also referred to publications stating that in most cases the NBR better represents observed count data than the Poisson regression (32, 33).

The ZINBR is an extension of the NBR that is more accurate for modelling count variables with overdispersion due to preponderance of zero counts (31, 32). This type of overdispersion cannot be modelled accurately with the NBR, and the ZINBR model accounts for that deficiency. The ZINBR analyses involve building two regression equations: the first is for predicting zero count (a binary outcome), and the second is for predicting the remaining counts (a discrete outcome) (31, 32). A decision on whether the ZINBR was more appropriate than the NBR in a particular situation was based on use of the Vuong test (31, 32). The ZINBR was preferred over the NBR when a value of the Vuong test was positive and significant (31). Having 72 monthly observations and 3 covariates in all our regression models did not allow us using the ZINBR when an outcome variable had <30 non-zero values as this would have led to violations of the rule of thumb '10 events per predictor variable' (35) for a regression with dichotomous outcome (logistic regression), which de facto is the first step in the ZINBR analysis.

Robust standard errors were calculated for all regression coefficients to adjust for heterogeneity in the models with respect to outliers and potential misspecification (31, 36).

Seasonal variation was modelled in all regressions by trigonometric sine [Sin(2πt/12)] and cosine [Cos(2πt/12)] functions with a periodicity of 12 months (36-38). Notably, we were investigating long term trends in the data which should not be dependent on seasonal variation, given this variation was constant within the study period. Therefore, control for seasonal variation was performed in order to improve quality of the models by letting them better explain variation in the outcome variables and get smaller standard errors for the coefficients, rather than to control for confounding from seasonality.

Average percent changes (APCs) in monthly occurrence of crashes, fatalities and non-fatal injuries with 95% confidence intervals (CI) were estimated from NBR or

ZINBR regression coefficients and corresponding CIs by multiplying them by 100. APCs in monthly occurrence of pedestrian-motor vehicle crashes per unit changes in safety measure variables were estimated similarly (Paper III).

To account for changes in the total population, the logarithm of the mid-month total population was included in regression models as an offset variable. Similarly, control of changes in the total number of motor vehicles was performed by using the logarithm of the mid-month total number of motor vehicles as an offset variable. Therefore, APCs from models where the logarithm of the mid-month total population was included as an offset variable reflected trends in the rates per total population. Correspondingly, the APCs from models with the logarithm of the mid-month total number of motor vehicles as an offset variable reflected changes in the rates per total number of motor vehicles.

Notably, analyses of trends in mortality data were performed with adjusted counts of fatalities for 2005-2008 (adjustment factor of 1.08, as recommended by the ECMT), and unadjusted numbers for 2009-2010 (Paper I).

All regression analyses were performed using STATA v.12.1 (39).

Data reliability analyses

Comparison and matching of the data on traffic fatalities of the police with those collected by the health sector are common ways to assess completeness and reliability of traffic injury and mortality data (20, 22, 25, 40-46). Capture-recapture method is most often used for these purposes (25, 41-43, 45).

The four key assumptions of the capture-recapture method are: (i) capture and recapture sources are independent from each other; (ii) the record-linkage is perfect and has no errors; (iii) the studied population is closed for in- and out-migration during the study period; and (iv) all cases in the studied population have the same probability of being ascertained (41-43, 45, 47-51). The first three assumptions would clearly be violated in our data reliability study linking the police and the healthcare data: (i) the police and the healthcare data systems are dependent because of national rules for accounting traffic casualties; (ii) perfect linkage is not possible in many cases due to incompatibility of the definitions in the two registration systems as well as failures and scarce identifying information in the data; (iii) migration of cases occurs between ascertainment in the compared sources (for example, a case can be injured in a crash at one place and die in a hospital at another place). Therefore, the customary capture-recapture method was not applicable for our study and we attempted to adapt and employ measures of diagnostic accuracy (52-54) to estimate and compare the reliability of the two traffic mortality data sources.

We started from matching the police and the healthcare data on four variables: date of injury, date of birth, gender and road user type. Cases were considered matched if the date of crash (injury) was the same in the two sources, or differed maximum by ±1 day, and the other variables were identical. Soon after starting this procedure we discovered that matching on the date variables was problematic because of imprecise dates of crashes (injuries) in the healthcare data. According to the healthcare statistics centre, this imprecision was caused by existing practice of recording the date of injury as identical to the date of death when no exact date of injury is specified in death certificate and other medical records. An approximately estimated date of birth was also a common problem, specifically in the police data.

Similar data deficiencies were acknowledged by other authors (43, 55, 56). These shortcomings of the data distorted our initial plan of matching on the four variables, and we had to facilitate it by initiating the legally mandated procedure of the police versus the healthcare data verification (1). This procedure was performed by authorized employees of the police and the healthcare statistics centre and involved matching by name (first, middle, and last), gender, date of birth, date of injury and road user group (group A: pedestrian or bicyclist; group B: driver or passenger of a motorized four-wheeled vehicle; group C: motorcycle rider or passenger). Place of residence was used as a supplementary matching variable where possible. Matching was considered achieved if at least the first and last name, gender, road user group, and year of injury were the same in both datasets. Casualties that were ‘unidentified’ (had non-established name and only an approximate estimate of year of birth) in one or both datasets were considered matched if the date of injury, gender, and road user group were the same, while the estimated year of birth was similar (±10 years). All the matching was performed manually.

Cases in the police data that remained unmatched to the healthcare data were searched for in the regional mortality register of the healthcare statistics centre among all causes of death. In parallel, cases in the healthcare data without matches in the police data for the city were searched for in the regional police database of traffic accidents with fatal and-non fatal injuries among all registered traffic fatalities and injuries in the Arkhangelsk region. Both searches were performed by employees of the police and the healthcare statistics centre. If an unmatched case was identified in either of the sources, a cause of the failed matching was noted and recorded. Based on all this, the non-matches were categorized into five classes: (a) non-matches due to incompatibility of definitions in the two data registration systems; (b) non-matches due to the police data failures (confirmed false positives and false negatives); (c) non-matches due to the healthcare data failures (confirmed false positives and false negatives); (d) non-matches due to scarce identifying information (the corresponding cases were regarded as potential false positives in the source where they were present with scarce information and as potential false negatives in the source where they were absent); and (e) non-matches due to not established causes (the same ambiguity regarding the corresponding cases). The categorization was performed and the results agreed upon by three persons: the police employee, the employee of the healthcare statistics centre, and the author of the thesis.

The obtained distribution of non-matches by causes was used to calculate estimates of true numbers (ETN) of traffic fatalities in Arkhangelsk in 2005-2010 for both the police and the healthcare data in appliance with corresponding registration systems and definitions:

$$ETN_{\text{police data}} = \Sigma_{\text{cases in the original police data}} - \Sigma_{\text{confirmed false positives in the police data}} + \Sigma_{\text{confirmed false negatives in the police data}} - \Sigma_{\text{potential false positives in the police data}} + \Sigma_{\text{potential false negatives in the police data}}$$

$$ETN_{\text{healthcare data}} = \Sigma_{\text{cases in the original healthcare data}} - \Sigma_{\text{confirmed false positives in the healthcare data}} + \Sigma_{\text{confirmed false negatives in the healthcare data}} - \Sigma_{\text{potential false positives in the healthcare data}} + \Sigma_{\text{potential false negatives in the healthcare data}}$$

The calculated ETNs are the estimates of total cases to be present in a data source according to a sort of a ‘gold standard’. According to such a ‘gold standard’ for each data source, every case in our combined set of the police and the healthcare data was categorized as present (positive), absent (negative), or ‘unclear’ (either as positive in the source where it was present or as negative in the source where absent). For each source, the distribution of all cases in the combined dataset according to the corresponding ‘gold standard’ was cross-tabulated with the presence or absence of cases in the original data. Therefore, for both data sources we have got 2x3 tables (Table 1).

Table 1 Distribution of cases in accordance with the estimated ‘gold standard’ for a data source compared to their presence-absence in the original data of the same source

		According to ‘gold standard’		
		present	absent	‘unclear’
In original data	present	True Positives	False Positives	Potential False Positives
	absent	False Negatives	True Negatives	Potential False Negatives

The assessment of the data reliability in the two sources was initially intended to be performed by use of the standard formula for diagnostic accuracy (52-54):

$$\text{Accuracy} = (\text{True positives} + \text{True negatives}) / (\text{True positives} + \text{True negatives} + \\ + \text{False positives} + \text{False negatives})$$

However, to solve the problem of ‘unclear’ cases in each data source, we had to adapt the accuracy formula to these specific features of our study. Therefore, the potential false positives and potential false negatives were included into its denominator in addition to the confirmed false positives and confirmed false negatives. This gave the formula of what we called a data accuracy index (DAI):

$$DAI_{source} = (\text{True positives} + \text{True negatives}) / (\text{True positives} + \text{True negatives} + \text{Confirmed false positives} + \text{Confirmed false negatives} + \text{Potential false positives} + \text{Potential false negatives}) * 100$$

With the denominator including potential false positives and potential false negatives, a DAI gives a conservative estimate of the data accuracy in a source (tends to underestimate rather than overestimate it). Otherwise, interpretation of a DAI value has no difference from interpretation of a customary accuracy value. Thus a DAI value of 100% reflects absolute accuracy of the data and allows concluding its high reliability, while a DAI value tending towards zero means poor data accuracy and reliability. With this assumption, DAIs were used to judge and compare reliability of the two data sources over the study period.

To estimate changes in the data reliability of our sources over the study period, the 6-year time trends in annual DAIs for both sources were investigated by Cochrane-Armitage χ^2-tests, which were performed using WinPepi program (57).

3.6. Ethical considerations

The overall study was approved on 23 March 2009 by the Ethical Committee of the Northern State Medical University, Arkhangelsk, Russia. None of the police and the healthcare data variables accessed for the purposes of this study by non-employees of the police and the healthcare statistics centre allowed personal identification of an individual.

4. MAIN RESULTS

'Road traffic crashes with fatal and non-fatal injuries in Arkhangelsk, Russia in 2005-2010' (Paper I)

From January 2005 to December 2010, the road police registered 4,955 crashes with fatal and non-fatal injuries in Arkhangelsk, which resulted in 217 fatalities and 5,964 non-fatal injuries.

The mid-year total population of Arkhangelsk decreased by 0.7% (from 356,773 in 2005 to 354,901 in 2010), and mid-year total number of registered motor vehicles increased by 30.2% (from 61,511 to 81,199). The total length of the city road network remained unchanged (512 km) over the study period. The rate of crashes with fatal and non-fatal injuries per total population did not change over the period, while the rate of these crashes per total motor vehicles decreased on average by 0.6% per month.

Pedestrian-motor vehicle crashes constituted 51.8% of all crashes with fatal and non-fatal injuries over the period. The rate of pedestrian-motor vehicle crashes per total population decreased on average by 0.3% per month, and the same rate per total motor vehicles decreased on average by 0.8% per month. This was the major trend within the data on crashes with fatal and non-fatal injuries.

The rate of total traffic fatalities was 13.7 (14.8 with the adjustment of 1.08) per 100,000 population in 2005 and 7.6 in 2010, but the change did not show a significant trend. However, the rate of fatalities per total motor vehicles decreased on average by 1.1% per month.

Pedestrians constituted 54.6% of all traffic fatalities over the study period. The rate of pedestrian fatalities per total population did not show a trend, but the rate of pedestrian fatalities per total motor vehicles decreased on average by 1.1% per month. This was the most pronounced trend in the data on traffic fatalities.

The rate of non-fatal injuries was 282.3 per 100,000 population in 2005 and 259.2 in 2010, and the change did not show a trend. At the same time, the rate of non-fatal injuries per total motor vehicles decreased on average by 0.6% per month.

Pedestrians constituted 44.5% of all non-fatal traffic injuries. The rate of non-fatal injuries in pedestrians per total population decreased on average by 0.3% per month, and the rate of non-fatal injuries in pedestrians per total motor vehicles decreased on average by 0.8% per month. This was the key trend in the data on non-fatal traffic injuries.

'Road traffic fatalities in Arkhangelsk, Russia in 2005-2010: reliability of police and healthcare data' (Paper II)

The police registered 217 traffic fatalities in Arkhangelsk in 2005-2010 while the healthcare statistics centre registered 237 traffic fatalities over the same period. Matching of cases from the two data sources resulted in a database of 292 cases, including 162 matched cases and 130 non-matched cases. Out of the total of non-matched cases, 55 were in the police data, and 75 were in the healthcare data.

Over a half (56%) of the total non-matches were attributed to the incompatibility of the definitions in the police and the healthcare data registration systems. Failures in the healthcare data accounted for 39% of the total of non-matches. Other non-matches were due to scarce identifying information in either of the sources (2%), or were regarded not classifiable because their causes could not be established (2%). None of the non-matches were clearly attributable to failures in the police data.

The 6-year total estimated true number (ETN) of traffic fatalities for the police data was 219, while the ETN for the healthcare data was 284. The estimated 6-year data accuracy index (DAI) for the police traffic mortality data was 98%, while the estimated DAI for the healthcare data was 80%. The DAI for the police data was stable in 2005-2010, and ranged from 96% to 100%. The DAI for the healthcare data decreased from 66% in 2005 to 57% in 2007, and thereafter increased up to 91% in 2008, 93% in 2009, and 98% in 2010.

'Explaining reduction of pedestrian-motor vehicle crashes in Arkhangelsk, Russia in 2005-2010' (Paper III)

During the 6 years, the police registered 2565 pedestrian-motor vehicle crashes which resulted in 117 pedestrian fatalities and 2556 non-fatal pedestrian injuries. Out of the total of pedestrian-motor vehicle crashes, 62% occurred outside crosswalks, 30% on non-signalized crosswalks, and 8% on signalized crosswalks.

Over the study period, pedestrian-motor vehicle crash rates outside crosswalks and on signalized crosswalks decreased on average by 1.1% per month, while the rate of pedestrian-motor vehicle crashes on non-signalized crosswalks remained unchanged.

The total number of signalized crosswalks in Arkhangelsk increased by 14% over 2005-2010, and the total of non-signalized crosswalks increased by 19% in 2009-2010. During 2005-2010, 10% of the non-signalized crosswalks in the city were combined with speed humps, and 4% were equipped with new light-reflecting vertical signs instead of regular old ones.

Pedestrian fines for traffic offences (ignoring prohibiting traffic signal, crossing outside crosswalk, and walking on road) had 2-fold nationwide increases in the study period: in July 2007 and in May 2009. Driver fine for ignoring prohibiting traffic signal had a nationwide 7-fold increase in January 2008. Driver fine for failure to give way to a pedestrian on non-signalized crosswalk increased 8-fold in May 2009. The average fines for these traffic offences increased in Arkhangelsk accordingly.

The police registered the total of 747,943 traffic offences over the study period. Out of the total, 88% were offences by drivers and 11% were offences by pedestrians. Over the study period, the mean monthly rate of registered driver offences was 12.7 per 100 motor vehicles, and the mean monthly rate of registered pedestrian offences was 0.3 per 100 residents. The rate of registered driver offences per 100 motor vehicles decreased on average by 0.3% per month, while the rate of registered pedestrian offences per 100 residents showed no change.

All infrastructure measures, except for the introduction of new non-signalized crosswalks, and all legislative measures showed significant inverse associations with the rate of pedestrian-motor vehicle crashes outside crosswalks. The rate of pedestrian-motor vehicle crashes on signalized crosswalks due to driver and pedestrian offences showed inverse associations with increases of pedestrian and driver fines for corresponding traffic offences. None of the studied pedestrian safety measures showed associations with the rate of pedestrian-motor vehicle crashes on non-signalized crosswalks.

‘Injury Prevention and Safety Promotion course in a Russian Master of Public Health programme’ (Paper IV)

The curriculum of the course covers topics of the Global Burden of Injuries (5, 58), injury epidemiology, injury surveillance, and gives an overview of strategies for action plans and interventions. The course literature consists of a book ‘Injury Epidemiology: Research and Control Strategies’ by Leon S. Robertson (59) and a number of articles and reports on the global injury panorama and possibilities for injury prevention and safety promotion. Teaching methods include preparatory home tasks, in-class lectures, seminars, group assignments, and a home exam. Injury prevention and safety promotion professionals with international scientific background and practical experience are used as main teachers.

In 2007-2010, 53 students passed the course, 77% being females. The majority of students was constituted by medical doctors (51%), psychologists (11%), pedagogues (9%), dentists (6%), and nurses (6%). The students were representing six areas of Russia: most of them were from the Arkhangelsk city and Arkhangelsk region (90%), while Murmansk region, Vologda region, the Komi republic, St. Petersburg, and Moscow were represented by one student each.

Training-the-trainers programme was run in the course during 2008-2010 with four Russian students of excellence being the trainees. The training-the-trainers programme consisted of in-class teaching under supervision of the main teachers, tasks regarding organization of students' self studies, training in pedagogics, and participation in international conferences on injury prevention and safety promotion topics. The proportion of in-class teaching by Russian trainees was gradually increasing from 23% in 2008 to 86% in 2010. In 2012, the take-over programme is completed and the course became a full responsibility of Russian teachers – former trainees.

Student evaluation of the course was performed on yearly basis and touched upon issues of the course content, organization, and pedagogic approach. The evaluation was based on visual analogue scales (range 1-10) and open-ended questions. The average rankings on the scales 'Overall impression of the course', 'Content of the course', 'Teaching methods', and 'Lecturer's pedagogic skills' were 8.7, 8.1, 8.3, and 8.2, respectively. The most common suggestion for improvement of the course was 'more practical classes and group work'.

Student evaluation of the performance of the trainee-teachers was added up to the evaluation form in 2010. The mean rankings of course trainees on their teaching performance varied 7.4-9.5. The student ratings of the trainees were in line with evaluations by the main teachers.

5. GENERAL DISCUSSION

5.1. Methodological considerations

The overall goal of an epidemiologic study can be viewed as accuracy in estimation of the frequency of a health outcome or of the effect of an exposure on the occurrence of an outcome (60). A study is considered accurate when its design, methods, and procedures are unbiased, and the produced results are valid and precise, and thus are close to the truth (61). Therefore, accuracy of a study implies its minimized susceptibility to both random and systematic errors (60).

Validity of a study largely refers to lack of systematic errors, or biases (60). The overall validity of a study is usually separated into two types: internal validity and external validity (60, 62-64). The internal validity is the validity of the findings as they pertain for the source population of the particular group of subjects being studied (60, 62). The prerequisite of internal validity is the lack of systematic errors: selection bias, measurement bias, and confounding (60, 62). As for the external validity, also called generalizability, it is the validity of the findings as they pertain beyond the source population – to a target population or other populations (60, 65, 66). So the issues of external validity refer to whether findings can be generalized to different types of persons, populations, settings and times (63). Generalizability of the findings depends upon the internal validity of the study, because it is impossible to generalize an invalid finding (63, 64). However, internal validity of a study does not guarantee its external validity (62).

Selection bias

Selection bias arises from distortions in procedures used to select subjects and from factors that influence study participation (60, 61). It occurs when there is a non-random difference between the characteristics of people selected for a study and the characteristics of those who are not (62). An advantage of our studies is that we were using data on all traffic crashes, fatalities and non-fatal injuries in the city of Arkhangelsk in the study period, and did not take samples from its population. Therefore, our studies are not susceptible to selection bias.

Information bias

Information bias originates from errors in measurements of study variables (60, 62). For discrete or count variables, which are the most common variables in our studies, measurement error is referred to as classification error or misclassification (60, 67). Hereafter we discuss several issues in our studies that are related to the concept of information bias.

Completeness and reliability of the police data

The police database of crashes with fatal and non-fatal injuries was the major source of data used in our studies. This police database has links to databases of two other types of institutions at a Russian setting that also do registration of road traffic crashes and casualties – healthcare institutions and insurance companies. According to the national rules for accounting of traffic casualties, healthcare institutions are obliged to report all cases of traffic fatalities and injuries to the police, and the information about the cases is added to the police database if the data are missing there. Besides, the police are empowered to verify their own data on registered cases against the data of healthcare institutions (1). In addition, all crashes in Russia, including crashes with only property damages, are subjected to investigations of legal issues by the police before crash participants can apply for insurance refunds of damages and healthcare expenditures. This encourages crash participants to inform the police even about minor crashes. Logically, existence of this legal and administrative system makes the police the most complete data source on crashes with fatal and non-fatal injuries for a Russian setting.

Nevertheless, to be on the safe side when defending reliability of our main data source, we performed a study to estimate and compare the reliability of the police and the healthcare traffic mortality data (Paper II). Notably, in planning of this study we considered using the third existing source of data on traffic fatalities – insurance companies. However, we refrained from doing that for two reasons: (i) there is a variety of insurance companies in the city and practical collection of data from all of them is complicated; (ii) the insurance data would anyway be dependent on both the police and the healthcare data as the insurance is not paid until the death is certified by the healthcare, and the cause of death is documented by the police. Our study has shown that registration errors (false positive and false negative cases) occurred more frequently in the healthcare traffic mortality data, and this allowed inferring a higher accuracy and reliability of the police data. Based on that, it is reasonable to assume that the police data on non-fatal injuries is also more reliable than the analogue healthcare data. Thus, we believe that our study provided additional evidence basis to state that the police database of crashes with fatal and non-fatal injuries is the most reliable and complete out of the existing sources of the road safety data for the study area.

In spite of our efforts to get correct estimates of the reliability of the police and the healthcare data, the design of our reliability study might have some limitations. First, our conclusions about the data reliability were based on cross-validation of the two dependent data sources against each other, while there was a possibility of unregistered traffic fatalities in both of them (20, 49). Therefore, there can be non-established false negative cases in both sources, and this might have led to overestimation of their reliability (50). However, we believe this problem could not be sufficiently large to bias our conclusions substantially. This is argued with the assumption that a traffic death is a rather serious event not to be often missed in a Russian setting by both the police and the healthcare sector. An alternative problem might have arisen from having false positive cases in both sources. For example, some of the traffic fatalities in the study could in fact be deaths from other causes which occurred during driving. Also some fatalities can be unascertained traffic suicides (68). Over the study period of six years, the Arkhangelsk police have identified only four natural deaths during driving, and no traffic suicides. This may reflect lack of autopsies and in-depth event history investigations. This potential problem of non-established false positive cases in our study could have led to overestimation of the data reliability of both sources. However, likewise with the previously discussed problem, the possible number of these cases cannot be that large to affect our conclusions substantially.

Finally, one more problem might have originated from deficiencies of our matching procedure. For instance, aside from the non-established false positive and false negative cases within the two sources, we might have got some false positive and false negative matches between the two sources (48, 56). False negative matches could have resulted from data inaccuracies and registration errors in the two sources and might have led to underestimation of the reliability of both sources (48, 49). We tried to address this problem by a thorough individual investigation of all non-matches and their causes, hence it also should not be large enough for a strong effect on our conclusions. Contrariwise, our efforts to minimize the number false negative matches might have resulted in occurrence of some false positive matches, and these might have led to overestimated reliability of both sources. Again this problem could not cause a substantial bias in our conclusions as the false positive matches are not likely to occur when the matching is based on several variables, including names.

We thus argue that (i) all the mentioned possible biases could not be large and (ii) they were tending to skew our results in opposite directions, somehow balancing each other. For these two reasons, their combined effect should not have reduced the validity of our study substantially.

Precision of the police data

Low precision of measurements and frequent random errors in classification of study participants can also lead to a bias that is called nondifferential (or random) misclassification (61). This type of information bias always leads to an underestimation of the true strength of the relationships of the imprecisely measured variables with other variables in the study (62, 65). Therefore, precision of the police data variables was one more validity concern in our study.

Possible imprecisions and random misclassifications in the police data may have resulted from: (i) factual lacks of the information (for example, a date of birth cannot be stated precisely when the personal identity of the traffic fatality is not established), (ii) errors and inaccuracies during filling of the crash report forms, and (iii) faulty punching of the data into electronic databases.

We noted that 11% traffic fatality cases in the police data had imprecise records of the dates of birth – only a year of birth or its approximate estimate (Paper II). Precision of other police variables used for the purposes of our reliability study was high, as no inaccuracies were observed when verifying their contents against the healthcare data, except for missing names and places of residence for 8% of fatality cases (as reported by the police employee who performed the name-based data verification procedure), and missing gender for only one case. The precision of other police variables was difficult to judge as there were no direct indications of imprecision and no other comparable data sources to cross-validate the data.

To get a better hint of the likelihood of errors in the police database of crashes with fatal and non-fatal injuries, we used two more strategies. The first was to look at frequencies of missing values in the variables. These frequencies were ranging from zero for the key crash-related variables (date, time, type of crash) to very few occasions for crash-participant-related variables. For example, date of birth was missing for 11 and gender was missing for 3 out the total of 6181 registered traffic fatalities and non-fatal injuries in the study period. This was interpreted as an indication of general accuracy of the data. The second strategy was to check the consistency of the police variables against each other. For example, the variable 'type of road user' was checked against the variable 'type of motor vehicle'. No inconsistencies were found by these checks. For example, we identified no pedestrians with an indication of the type of used motor vehicle, and no drivers without indications of the type of used motor vehicle, except for some of the 'hit-and-run' cases. This was also considered to be an indication of a good accuracy and of the overall trustworthiness of the police data.

Ecological approach

We employed ecological study design to look at trends in crash, fatality and non-fatal injury data as well as to investigate associations between incidence of pedestrian-motor vehicle crashes and a number of infrastructural, legislative, and law enforcement pedestrian safety measures. The units of analysis in an ecological study are groups of people or populations, and not individuals (62, 66). Therefore, an outcome variable in such a study commonly consists of morbidity or mortality indicators for a number of populations, or for one population at different points in time (64). Correspondingly, ecological studies use aggregate measures of exposures, representing average exposure levels of populations rather than actual individual values (64, 69). Therefore, an ecological study is a good approach to estimate exposure-outcome relationships at individual level only when the exposure is homogenous (close to the average) for all individuals within a population, but this is rarely the case as individuals are heterogeneous with respect to many exposures. For that reason, the exposure-outcome relationships that are observed at the aggregate level may not reflect the exposure-outcome relationships at the individual level (69). This is a typical bias for an ecological study that is called an aggregation bias, or ecological fallacy (60, 62, 65, 66). Regardless of this problem, ecological studies are useful instruments for identifying factors responsible for differences in incidence of a health outcome between populations, or in one population at different time points (62, 69). Besides, ecological studies are useful for monitoring effectiveness of population interventions such as infrastructural, legislative and law enforcement road safety measures (69).

In our studies we used the aggregated monthly counts of crash outcomes and data on population-oriented road safety interventions to investigate trends in incidence of outcomes (Papers I, III) and their relations to interventions (Paper III). This approach allowed concluding about the crash trends in the city as well as about their associations with the interventions targeting general pedestrian safety in the city. However, potential ecologic fallacy problem creates limitations for concluding about the same changes in risks of crash outcomes for individual residents. This does not at all interfere with purposes of our studies, which were focusing on the city level rather than on individuals, and is not regarded as a problem. Moreover, we believe that our conclusions from the aggregate data analysis may be well applicable on the individual level, although they may not be equally correct for all Arkhangelsk residents which are not homogenous with respect to risk of traffic crashes.

A strength of our ecological studies (Papers I, III) is that our aggregate monthly data on crash outcomes in Arkhangelsk was built up from individual data on traffic crashes and casualties, and this original individual data was shown to be reliable (Paper II). Thus the data on monthly count numbers of the outcomes of interest can fence the critique of being imprecise. However, the weakness of our outcome variables – rates per total population and total motor vehicles – is that they were calculated as ratios of precise counts of events to less precise denominators. For instance, the total number of registered motor vehicles in the city (our most common denominator in rate calculations) was used as a proxy measure for the increasing traffic volume in the city – the number of vehicle kilometres driven on the city road network (70), while the data on real changes in the traffic volume were not available. Such approximation could have some effects on our estimates of the trends in the crash data as the traffic volume in the city might not change proportionally to the changes in the number of registered motor vehicles. Besides, the monthly totals of registered motor vehicles and total population in the city (used as denominators for calculating monthly rates) were estimated from annual data with assumption of linear monthly changes in these variables within each year. This might have further decreased the precision of our results. Anyway, there were no better alternatives, so we tried to make the best use of what we had. Besides, the appropriateness of our approach is backed up by the fact that rates of traffic events per 10,000 motor vehicles are commonly used to adjust for differences in traffic exposure in comparative studies (71, 72).

Similar comments are applicable to our data on some of exposure variables. For instance, the intensity of police enforcement regarding drivers and pedestrians was estimated as ratios of totals of registered driver and pedestrian traffic offences to totals of registered motor vehicles and population, respectively. The approximate values of the denominators gave the proxy estimates of the intensity of the police enforcements, and this may have caused some insubstantial biases in observed associations of these road safety measures with related crash rates.

Change of the police's traffic fatality definition

A notable potential threat to the validity of our conclusions regarding trends in the traffic mortality data (Paper I) is the change of the police fatality definition around the middle of the study period. We addressed this problem by applying the standardized 30-day traffic fatality adjustment factor of 1.08 to the police mortality data for the period from 2005 to 2008, when the 7-day definition was used (30). This should have helped to control biases towards underestimation of the downward trends in the mortality data. However, appliance of a crude adjustment factor could not completely eliminate the bias, and should have reduced precision of our trend estimates. So we tried to find and use the most suitable way to deal with the problem of the changed definition, but, as it commonly occurs in real life, getting very close to the 'gold standard' was not possible.

Confounding

The term 'confounding' comes from the Latin word 'confundere', meaning 'to mix together', and is used to describe a distortion of an effect of the exposure of interest because of its mixture with the effect of an extraneous variable, or a group of variables (61, 62, 65, 66, 73). To be a confounder, a variable must be a determinant of an outcome (that is to be an etiologic or a protective factor) and must be associated with the exposure under investigation (62). Confounding is a problem in situations when the association between an exposure and an outcome is masked because of the influence of other variables that are not accounted for in the study design or data analysis (73).

Lack of ability to control for the effects of potential confounders is one more serious limitation of ecological study deign (64, 69). Commonly, the underlying problem of ecological studies is the lack of aggregate data on potential confounders. Without having this data, control of confounders in analysis is not possible. Also the overall importance of controlling for confounding in all types of observational studies of the effects of road safety measures should not be underestimated (74). Therefore, using the ecological design to investigate associations between occurrence of pedestrian-motor vehicle crashes and pedestrian safety measures (Paper III) we had to pay special attention to the potential confounding. Paramountly, we tried to control for changing traffic volume in the city by including the logarithm of the total number of motor vehicles (proxy variable for traffic volume) as an offset variable into all regression models. Therefore, all our calculated APCs are virtually the APCs in the rates of pedestrian-motor vehicle crashes per total motor vehicles and cannot be underestimated due to confounding from changing traffic volume. Alternatively, our strategy to control for traffic volume may have resulted in some over-control of this potential confounder as it has been shown that 'when the traffic grows by *X*%, the number of accidents tends to increase by less than *X*%' (70, 74). Besides, the growth of traffic volume might have been less than the growth in number of registered motor vehicles (our proxy variable) as having a car does not mean always using it. Balancing these arguments against controlling for the increase of the total number of motor vehicles (+37%) versus logical arguments in favour of controlling for it, we concluded that a larger bias would be present if we do not control. This decision was backed up by our earlier finding (Paper I) that the rate of pedestrian-motor vehicle crashes was decreasing not only if calculated per total motor vehicles, but also if calculated per total population. This is an additional argument for: (i) a true reduction in pedestrian-motor vehicle crashes in the study period, and (ii) causality between the introduced safety measures and the reduction (Paper III).

Regression to the mean is a well-known confounder in before-after studies of road safety measures (74-76). It is commonly a problem in evaluations of road safety interventions addressing road sites with high crash occurrence, traditionally referred to as ‘black spots’ (77-80). Accordingly, these interventions are called ‘black spot treatments’. The essence of the regression to the mean problem is that an observed effect of a ‘black spot treatment’ may only partially be due to the intervention. It may largely be explained by a common situation when the initial high number of crashes at a ‘black spot’ is a random fluctuation artefact, and the observed reduction in crashes after ‘treatment’ is a recurrence of the number of crashes towards its long-term mean value. It is also acknowledged that the potential confounding effect of the regression to the mean is reduced with increasing number of observations before and after an intervention, when it is possible to calculate the average change (81). In our study (Paper III), regression to the mean was not considered as a potential problem for two reasons: (i) the studied interventions were not the ‘black spot treatments’ but population-oriented interventions addressing long term road safety problems; (ii) the associations were studied in regression analyses with 72 monthly observations of crash rates that took place before, after, and along with introduction of the safety measures. As a result, average monthly percent changes (APCs) were calculated and random variation became not likely an explanation of the decrease in crash rates. Therefore, regression to the mean could not have a considerable impact on our conclusions.

Long term trend is a one more factor to be controlled in the studies of effects of road safety measures (74). However, confounding from the long term trend was not likely in our study because there were no indications of a long-term downward trend in pedestrian-motor vehicle crashes in Arkhangelsk. For that reason no control for long-term trend was performed.

In spite of our consideration of potential confounding from increasing number of motor vehicles, the regression to the mean and the long term trend, we have to acknowledge a lack of control for other potential confounders. For instance, the detected associations between the safety measures and pedestrian-motor vehicle crashes (Paper III) may to some degree be explained by the effects of other factors in the study period. A list of these factors may include: (i) general reduction of the speed of motor vehicles in the city due to increased traffic volume on the unchanged total length of the city road network; (ii) decreasing pedestrian exposure along with increasing number of motor vehicles; (iii) growth of public awareness of the road traffic dangers due to ongoing mass media and educational road safety campaigns; (iv) increasing proportion of new vehicles with pedestrian friendly car front design; (v) improved visibility of pedestrians due to increasing offers and popularity of clothes and accessories with light-reflecting elements. Control of these confounders was not performed due to data limitations: the data on corresponding variables is not routinely collected for the Arkhangelsk city and could not be measured retrospectively. A relevant strategy to control for confounders in an evaluation before-after study of road safety measures is to include a control (or comparison) site where no studied measures are introduced. This would be called a controlled before-after study (82, 83). However, the investigated pedestrian safety measures had nationwide dimension (14) and there were no city in the Northwestern Russia where these measure were not implemented – no ‘control city’ was available. Furthermore, our study (Paper III) was retrospective and tried to explain the earlier identified reduction in pedestrian-motor vehicle crashes, and not to investigate the effects of a particular safety measure. Therefore, a design of a controlled before-after study, normally being a prospective study with clearly defined intervention, did not fit our aims. Nevertheless, lack of confounding control is a limitation of our study. Although we believe that potential confounding from the abovementioned variables could not be strong enough to corrupt our conclusions substantially.

The last but not least to be mentioned in this section, the analyses in our study (Paper III) were limited to assessment of crude (unadjusted for potential confounding from each other) associations between the pedestrian safety measure variables and occurrence of pedestrian-motor vehicle crashes. This is due to the multicollinearity problem – a strong correlation (or concurrence) of the safety measures in time (31, 84). Thus a multivariable regression model would be ill-conditioned if the correlated safety measure variables were included as independent covariates. For that reason, adjustments of the crude associations between safety measures and crash outcomes for each other could not be performed. This is a real life situation that we encountered and had to accept for granted.

Generalizability

Findings of epidemiologic studies are useful if they are generalizable beyond study sample (or study population) to the source population, and potentially beyond that (65, 66). Generalizability of our findings to the source population is not a concern as we used data for the entire Arkhangelsk city. However, one can question a possibility of generalizing our findings beyond the Arkhangelsk boundaries.

There may be two alternative strategies to answer this question. The first is to explain that selection of Arkhangelsk was based on involvement of the author at Arkhangelsk International School of Public Health and established contacts with local police and health authorities. In that regard, the studies were attempting to define recent traffic safety developments and their determinants in the specified city with the purposes of adding up to evidence basis for further planning of local preventive activities. From that point of view, generalizability of the findings to other settings was not important.

Alternatively, one can say that Arkhangelsk is a typical Northwestern Russian middle-sized city. In that sense our results can be generalized to other similar cities in the Northwestern Russia, and perhaps to cities in other Russian regions and abroad. In our papers we intentionally did not mention a possibility of generalizing our findings to other places. By doing that we left it for a reader to judge whether Arkhangelsk is sufficiently representative for other urban areas in Russia or other countries for generalization of our conclusions.

Nevertheless, comparing our findings to results of similar studies and other published road safety observations and reports, we have got a number of arguments to say that our findings in Arkhangelsk are in some respects reflecting the situation in other Russian cities, in the country in general, in other former Soviet states, and in the global dimension. This is elaborated in a number of subsequent paragraphs of this section.

Our findings reflect the overall improvement of traffic safety in Arkhangelsk (Paper I), and this is generally in line with the national road safety statistics for the study period (8-10, 16, 17). Similar favourable trends in general road safety indicators were lately observed in Kazakhstan (85) and Lithuania (86).

One more finding is that pedestrians constituted more than a half of all traffic fatalities and nearly a half of non-fatal injuries in Arkhangelsk over the study period (Paper I).

This is similar to other Russian cities, for example, Moscow (87), Voronezh (88), and Tolyatti (89). Large proportions of pedestrians among total traffic casualties were also shown in various cities in other countries (90-92).

Taking only traffic mortality data (Paper I), the observed proportion of pedestrian fatalities among all traffic fatalities in Arkhangelsk (52% in 2010) exceeds the analogue national estimate (36% in 2010) (93). This discrepancy is also in line with the worldwide gap between pedestrian injury rates in urban areas with high pedestrian and vehicle activity compared to nationwide territories with considerable rural components and lower traffic and pedestrian volumes (13, 94, 95). That is to say, a distribution of traffic casualties by road user groups in Arkhangelsk is not directly comparable to the national statistics, just like the pedestrian safety situation in any other city is not comparable to a national pedestrian safety situation.

Our reliability study of the traffic mortality data of the police and the healthcare sector (Paper II) revealed a higher reliability of the police data. Given the accounting of traffic fatalities all over Russia is performed according to the same national regulations, the registration of fatalities by the police and the healthcare sector should be performed in the same way in Arkhangelsk and in other places. With respect to that, our conclusion of the higher reliability of the police data should be generalizable to the national level. From another point of view, our study has shown that lower reliability of the healthcare data in the study period was largely due to common errors in the ICD-10 coding, and that number of these errors reduced in recent years. Probability of such errors is dependent of the competence and accuracy of the coding-responsible personnel that may in fact consist of a small number of individuals. For that reason, frequency of these errors in the Arkhangelsk healthcare data may be different from the same frequency in other regions, given they had a more or less competent and accurate coding-responsible personnel. Therefore, generalizations of our findings regarding lacks of reliability in the healthcare data should be made with caution.

In our study attempting to explain the reduction of pedestrian-motor vehicle crashes in Arkhangelsk over 2005-2010 (Paper III), we discovered that the reduction was due to decreases in rates of crashes outside crosswalks and on signalized crosswalks, while the rate of crashes on non-signalized crosswalks remained unchanged. Our main explanations for these findings are: (i) the increase in number of non-signalized crosswalks in the city and (ii) the in-migration of pedestrian exposure from outside crosswalks due to legislative and infrastructure measures which were both motivating and coercing pedestrians to use crosswalks. An alternative explanation is that granting high priority to pedestrians on crosswalks may have resulted in their false feeling of full safety on crosswalks, may have provoked their carelessness of the danger of not being noticed by a driver, and thus may have resulted in increased likelihood of pedestrian-motor vehicle crashes at crosswalks (79). In the 'Status report on road traffic accidents in the Russian Federation up to 2011' we read: 'The number of pedestrian fatalities in 2008-2010 was decreasing, but increased slightly in 2011 (+ 0.6%). Within the total pedestrian fatalities, the number of fatalities outside crosswalks was steadily decreasing, while the number of fatalities on crosswalks had a tendency towards increase' [translation from Russian] (11). Given the introduced pedestrian safety measures were the same or similar all over the country, the suggested explanations of our findings may be applied to explain the national trends. Moreover, these explanations are applicable to situations in other countries. For example, Norway has second lowest pedestrian fatality rate in Europe (6.7 per

100,000 population) and the lowest proportion of pedestrian fatalities outside crosswalks out of total pedestrian fatalities (45%), but the proportion of pedestrian fatalities on crosswalks is the highest (55%) (96). The explanation is similar to our inferences: a combination of high density of crosswalks, pedestrian trust in and obedience to traffic rules and possibly pedestrians' carelessness of the danger of not being noticed by a driver at a crosswalk makes the crosswalks the most likely places in Norway for rare pedestrian-motor vehicle crashes to occur. Therefore, our findings and explanations of the unchanging rate of pedestrian-motor vehicle crashes on non-signalized crosswalks seem valid and generalizable as they are congruent and applicable to what we see at the national level and in the international contexts.

Finally, our study (Paper III) has shown that the reduction in rate of pedestrian-motor vehicle crashes in Arkhangelsk was associated with implementation of the set of infrastructural and legislative pedestrian safety measures during 2005-2010. Generalizability of this finding to other Russian and foreign settings may be supported by referring to a number of international studies that have shown worldwide effectiveness of infrastructure solutions (6, 77, 79, 80, 97-106) and legislative measures (79, 97) to improve pedestrian safety.

5.2. Practical implications and further research

In our studies we intended to utilize epidemiological and statistical methods for analysis of the routinely collected police data. According to the leadership of the Arkhangelsk police, our independent point of view and findings have helped them to better understand recent traffic safety developments in Arkhangelsk and their determinants. Besides, being performed in collaboration with the police, we believe our studies have opened up new perspectives to our collaborators on the analytical methods that can be used in their everyday practice. For instance, the necessity to control for growing traffic volume and other potential confounders when assessing crash trends and effects of interventions was well recognized by the police. It was also acknowledged that judgments of the changes in the situation on the basis of short-term observations (for example, a comparison of current year to the previous year) are often incorrect as the observed immediate changes often occur by random. Accordingly, it was agreed that longer time periods are needed for better estimates of real changes.

Our studies (Papers I, III) identified some deficits of the Arkhangelsk police data that do not allow clear-cut conclusions regarding causes of the observed changes in the road safety situation. Most notably, a cogency of any conclusion concerning changes in a crash risk cannot be high unless there is a precise data on changes in exposure variables (traffic volume and pedestrian volume) and appropriate control for these variables. Therefore, further research should be based on obtaining better data on exposures and potential confounders.

A practical implication of our research with respect to both local and international perspectives is the performed reliability assessment of the traffic mortality data of the police and the healthcare sector. Although our study was rather local (Paper II), its findings suggest that the police data on traffic fatalities has no clear-cut reliability deficits, and this supports its applicability for local road safety assessments and international comparisons. Thus an acknowledged concern about the quality of the official reports on traffic mortality in Russia (which are based on the police data) has been somehow addressed.

Also a practically important aspect of our data reliability study (Paper II) is that it described the difference between the Russian police and the healthcare sector in traffic fatality definitions and registration rules. This description addresses a common confusion regarding discrepancies between the traffic mortality reports of the Russian police and the healthcare sector, which can virtually be a key cause of excessive public distrust of both sources. Besides, the description of differences between the two data sources may become a basis for future traffic injury researchers to decide which source is more suitable for their research purposes.

Not least important, the findings of our data reliability study (Paper II) were used by the healthcare statistics centre in training seminars for hospital and forensic pathologists as examples of how their errors and inaccuracies in ICD-10 coding can affect the overall reliability of the healthcare reports on traffic mortality. Our hope is that the lessons are learned, and thus our study has contributed to the improvement of quality of the healthcare data on traffic fatalities. A next step in that regard can be a study of the reliability of the non-fatal traffic injury data of the police and the healthcare sector.

With respect to practical issues of preventing traffic crashes and casualties in Arkhangelsk, our findings (Paper III) and international literature (6, 77, 79, 80, 97-107) suggest that consistent continuation and enhancement of passive road safety interventions – infrastructural solutions and tightening of traffic legislation – should be an effective strategy to assure sustainability and further progress of the observed downward trends. There is also an unused potential of one more passive measure – strengthening of the police enforcement. This strategy, specifically if combined with social marketing campaigns, was shown effective internationally (6, 79, 80, 82, 83, 97, 98, 101, 102, 105, 107-112). However, the police enforcement in Arkhangelsk was not increasing, but decreasing over the study period.

Finally, the description of our successful experience of arranging the first master-level course on Injury Prevention and Safety Promotion at a Russian university may be a good example to follow for those with potentials of spreading safety concepts globally.

6. CONCLUSIONS

1. Over 2005-2010, there was no change in incidence of total crashes with fatal and non-fatal injuries in Arkhangelsk in relation to the total population. However, there was a decrease in incidence of crashes with fatal and non-fatal injuries relatively to a growing number of motor vehicles in the city. This general improvement in the road safety situation was largely due to reduction in incidence of pedestrian-motor vehicle crashes.

2. Traffic mortality data of the Arkhangelsk police were more reliable in the study period, compared to the healthcare data. However, the reliability of the healthcare traffic mortality data showed improvement during the study period.

3. The reduction in incidence of pedestrian-motor vehicle crashes in Arkhangelsk in 2005-2010 was associated with local infrastructural interventions and nationwide legislative road safety measures. The overall reduction in the incidence of pedestrian-motor vehicle crashes was due to reduction in incidence of pedestrian-motor vehicle crashes outside crosswalks and on signalized crosswalks. There was no change in the rate of pedestrian-motor vehicle crashes on non-signalized crosswalks.

4. There is a demand for knowledge of evidence-based approaches to injury prevention and safety promotion in the Northwestern Russia. The course on these topics attracts students with varying education. Some of them are interested and capable to become teachers, researchers, and practitioners of injury prevention and safety promotion.

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Paper I

Paper II

Paper III

Paper IV

Appendix

Police crash report form:

Original Russian version

and English translation

Original form in Russian language

Карточка учета дорожно-транспортного происшествия в Архангельской области

Район________________________________

Раздел 1. Общие сведения

Код региона	1111	Вид операции (обвести):
Учетный номер карточки (по ГРОВД)		1 - Направляется для записи
Дата: число, месяц, год		2 - Вносятся изменения
Время: час, мин.		3 - Изъятие карточки

Раздел 2. Место совершения ДТП

Населенный пункт	Статус населенного пункта	1 2 3 4			
Дорога № 1	Значение дороги	1 2 3 4 5 6		км	м
Дорога № 2		1 2 3 4 5 6		км	м
Улица № 1	Категория улицы	1 2 3 4 5		дом №	корп.
Улица № 2		1 2 3 4 5		дом №	корп.

Раздел 3. Вид и схема ДТП

Вид ДТП:

1 - столкновение
2 - опрокидывание
8 - падение пассажира
9 - иной вид ДТП

Наезд на:
3 - стоящее ТС
4 - препятствие
5 - пешехода
6 - велосипедиста
7 - гужевой транспорт

Код

Схема ДТП:

Код

Раздел 4. Дорожные условия

Элементы плана и профиля дороги		Код	
1 - Прямая в плане	2 - Кривая в плане	1 3	2 3
3 - Горизонтальный	4 - Уклон	1 4	2 4
5 - Конец спуска (начало подъема)		1 5	2 5
6 - Вершина подъема (начало спуска)		1 6	2 6
Сооружения и инженерные устройства дороги		Код	
1 - Мост, эстакада	2 - Тоннель		
3 - Пешеходный	4 - Перекресток		
5 - Перегон			
6 - Остановка общественного транспорта			
7 - Регулируемый ж/д переезд с дежурным			
8 - Регулируемый ж/д переезд без дежурного			
9 - Нерегулируемый переезд			
Вид покрытия		Код	
1 - Асфальтобетонное			
2 - То же, с поверхностной обработкой			
3 - Цементнобетонное			
4 - Щебеночное (гравийное)			
5 - То же, обработанное вяжущими матер.			
6 - Грунтовое			
7 - Иной вид покрытия			
Состояние проезжей части		Код	
1 - Сухое 2 - Мокрое	3 - Загрязненное		
4 - Свежеуложенная поверхностная обработка			
5 - Заснеженное	6 - Гололедица		
7 - Обработанное противогололедными материалами			
8 - Со снежным накатом			
Освещение		Код	
1 - Светлое время суток			
В темное время	2 - Включено		
3 - Не включено	4 - Отсутствует		
Состояние погоды		Код	
1 - Ясно 2 - Пасмурно			
3 - Туман 4 - Дождь	5 - Снегопад		

Дорожные условия, способствующие совершению ДТП			
01 - Неровное покрытие 02 - Дефекты покрытия			
03 - Низкие сцепные качества покрытия			
04 - Неудовлетворительное состояние обочин			
05 - Обочина занижена по отношению к проезжей части			
06 - Несоответствие габарита моста ширине проезжей части			
07 - Плохая видимость светофора			
08 - Неисправность светофора			
09 - Отсутствие горизонтальной разметки			
10 - Отсутствие вертикальной разметки			
11 - Деревья (опоры) на обочине			
12 - Наличие наружной рекламы			
13 - Отсутствие тротуаров (пешеходных дорожек)			
14 - Отсутствие ограждений в необходимых местах			
15 - Недостаточное освещение			
16 - Неисправное освещение			
17 - Сужение проезжей части (снег, строит. материал)			
18 - Наличие снежных валов, ограничивающих видимость, либо сужающих проезжую часть			
19 - Отсутствие ограждений, сигнализации в местах работ			
20 - Плохая видимость дорожных знаков			
21 - Отсутствие дорожных знаков			
22 - Неправильное применение дорожных знаков			
23 - Плохая различимость горизонтальной дорожной разметки			
24 - Ограниченная видимость			
25 - Отсутствие переходно-скоростных полос			
26 - Несоответствие параметров дороги ее категории			
27 - Несоответствие ж/д переезда предъявляемым требованиям			
28 - Неисправность переездной сигнализации			
29 - Отсутствие направляющих устройств и световозвращающих элементов			
* не более 3-х дорожных условий Код			
Ширина проезжей части, м			
Ширина обочины, м			
Ширина тротуара, м			
Ширина разделительной полосы, м			

Раздел 5. Сведения о транспортных средствах, участвующих в ДТП

	ТС № 1	ТС № 2	ТС № 3	ТС № 4
ТС скрылось с места ДТП: 1 - Нет, 2 - Да; Впоследствии задержано: 3 - 1 сутки,				
4 - от 1 до 3 суток, 5 - от 3 до 10 суток, 6 - свыше 10 суток				
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
ТС в розыске	1 - Нет 2 - Да	1 - Нет 2 - Да	1 - Нет 2 - Да	1 - Нет 2 - Да
Регион (область) регистрации				
Гос. рег. знак				
Тип транспортного средства				
Марка, модель				
Завод-изготовитель				
Свидетельство о регистрации	серия	серия	серия	серия
	номер	номер	номер	номер
Номер двигателя				
Номер кузова				
Номер шасси				
Год выпуска				
Цвет (оттенок):	0 - белый, 1 - желтый, 2 - коричневый, 3 - красный, 4 - оранжевый, 5 - фиолетовый, 6 - синий, 7 - зеленый, 8 - черный, 9 - иной.			
	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
Расположение руля и тип привода:	левый руль: 1 - передний, 2 - задний, 3 - полноприводной, правый руль: 4 - передний, 5 - задний, 6 - полноприводной, 7 - иной.			
	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Технические неисправности:	1 - работа тормозной системы, 2 - тормозной системы прицепа, 3 - рулевого управления, 4 - внешних световых приборов, 5 - износ рисунка протектора, 6 - отсоединение колеса, 7 - шины не соответствуют ТС, 8 - сцепного устройства, 9 - иные.			
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Факт. пассажировместимость на момент ДТП (водитель + пассажиры), чел.				
Количество прицепов, ед.				
Места наибольшего поврежд. ТС	2 3 4 / 1 9 (крыша) 5 / 8 7 6	2 3 4 / 1 9 (крыша) 5 / 8 7 6	2 3 4 / 1 9 (крыша) 5 / 8 7 6	2 3 4 / 1 9 (крыша) 5 / 8 7 6
Принадлежность				
Форма собственности				
Организ. прав. форма хоз. субъекта или министерство				
Предприятие (организация)				
Владелец (для физических лиц)				
Район учета				
Наличие лицензии	1 - Да	2 - Нет	3 - Нет данных	
	1 2 3	1 2 3	1 2 3	1 2 3

Раздел 6. Участники ДТП

	1-й УЧАСТНИК	2-й УЧАСТНИК	3-й УЧАСТНИК	4-й УЧАСТНИК
Скрылся с места ДТП: **1** - Не скрылся с места ДТП, **2** - Скрылся с места ДТП, **3** - Впоследствии разыскан, **4** - Не установлен				
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Схема: 2	3 / 4 / 5	4	6	Категория участника: **1** - Водитель, **2 - 6** Пассажир (по схеме) **7** - Пассажир (место не определено), **8** - Пешеход, **9** - Иной участник			
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Порядковый номер ТС, в котором находился данный участник ДТП				
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Фамилия				
Имя				
Отчество				
Пол	Мужск. Женск.	Мужск. Женск.	Мужск. Женск.	Мужск. Женск.
Дата рождения				
Степень тяжести последствий ДТП: **1** - Не пострадал, **2** - Ранен, **3** - Умер				
	1 2 3	1 2 3	1 2 3	1 2 3
Место жительства (страна, область, адрес)				
Место работы, должность				
Место службы (для сотрудников МВД, военнослужащих)				
Дополнительные сведения				
Социальная характеристика участника: **1** - Рабочий, **2** - Служащий, **3** - Военнослужащий, **4** - Пенсионер, **5** - Безработный, **6** - Учащийся, **7** - Предприниматель, **8** - Сотрудник МВД, **9** - Иной	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Водительское удостоверение (временное разрешение)	серия номер	серия номер	серия номер	серия номер
Водительский стаж, лет				
Время за рулем до ДТП, час				
Нарушение ПДД*				

(Коды нарушений ПДД смотри на обороте) *Не более 3-х нарушений

Нарушения ПДД водителями:
01 - Не имеет соответствующей категории на управление ТС данного вида;
02 - Не имеет права на управление ТС; 03 - Управление ТС в состоянии опьянения;
04 - Превышение установленной скорости; 05 - Несоответствие скорости конкретным условиям;
06 - Выезд на полосу встречного движения; 07 - Несоблюдение очередности проезда;
08 - Неподача или неправильная подача сигнала; 09 - Ослепление светом фар; 10 - Неправильный выбор дистанции;
Нарушение правил:
11 - Обгона; 12 - Перестроения; 13 - Буксировки; 14 -Перевозки людей; 15 - Остановки и стоянки;
16 - Проезда остановок трамвая; 17 - Проезда пешеходного перехода; 18 - Погрузки, перевозки и крепления грузов;
19 - Проезда ж/д переездов; 20 - Пользования светом фар;
Нарушение требований:
21 - Сигналов светофора; 22 - Линий разметки; 23 - Сигналов регулировщика; 24 - Дорожных знаков;
25 - Стоянка на проезжей части или обочине без освещения; 26 - Эксплуатация технически неисправного ТС;
27 - Эксплуатация незарегистрированного ТС; 28 - Другие нарушения ПДД
62-ТОНИРОВКА НЕ ПО ГОСТу
Пешеходами:
31 - Переход через проезжую часть вне пешеходного перехода;
32 - Переход через проезжую часть в неустановленном месте; 33 - Неподчинение сигналам регулирования;
34 - Неожиданный выход из-за ТС; 35 - Неожиданный выход из-за стоящего ТС;
36 - Неожиданный выход из-за сооружений (деревьев); 37 - Ходьба вдоль проезжей части при наличии тротуара;
38 - Ходьба вдоль проезжей части попутного направления вне населенного пункта;
39 - Игра на проезжей части; 40 - Пешеход в возрасте до 7 лет без взрослого;
41 - Нетрезвое состояние; 42 - Иные нарушения ПДД (пассажирами).

Раздел 7. Дополнительные сведения (Ф. И. О., диагноз пострадавших, куда доставлен)

1-й участник

____

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2-й участник

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3-й участник

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4-й участник

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Примечание:
Первый экземпляр карточки в срок не свыше 3-х суток направляется в ГИБДД УВД субъекта Российской Федерации, а дубликат карточки хранится в подразделении ГИБДД в течении двух лет (приказ № 328 МВД РФ).

Карточку составил____________________
Дата______________ № по КУП______________
Дата______________ № по ЖУИ______________

Начальник ГИБДД (ГО-РОВД)

____

Translation to English language

Report form on a road-traffic accident (crash) in Arkhangelsk region

District ______________________________

Section 1. General information

District code	1111	Type of operation (circle):
Registration number of the form		1 - forwarded for recording
Date (day, month, year)		2 - changes are made
Time (hour, minute)		3 - withdrawal of the form

Section 2. Place of crash

Settlement	Status of settlement	1 2 3 4		
Road № 1	Type of road	1 2 3 4 5 6		km m
Road № 2		1 2 3 4 5 6		km m
Street № 1	Category of street	1 2 3 4 5		house № building
Street № 2		1 2 3 4 5		house № building

Section 3. Type and scheme of crash

Type of crash:	*Hitting:*	Code	Scheme of crash	Code
1 - collision	3 - a standing vehicle			
2 - rollover	4 - a fixed object			
3 - passenger's fall	5 - a pedestrian			
9 - other crash	6 - a bicyclist			
	7 - an animal-drawn transport			

Section 4. Road conditions

Elements of road plan and profile		Code	
1 - straight line	2 - curved line	1 3	2 3
3 - horizontal	4 - slope	1 4	2 4
5 - end of downhill (start of uphill)		1 5	2 5
6 - top of uphill (start of downhill)		1 6	2 6

Road constructions and engineering solutions	Code	
1 - bridge, overpass; 2 - tunnel		
3 - pedestrian crosswalk; 4 - junction (crossroads)		
5 - span (midblock)		
6 - public transport stop		
7 - regulated railway crossing with attendant		
8 - regulated railway crossing without attendant		
9 - unregulated railway crossing		

Type of road surface	Code
1 - asphalt-concrete	
2 - the same, with surface treatment (by crushed stone, ravel, or sand)	
3 - cement-concrete	
4 - crushed stone (gravel)	
5 - the same, treated with astringent materials	
6 - soil (ground)	
7 - other	

Condition of road surface	Code
1 - dry; 2 - wet; 3 - dirty	
4 - freshly treated (by crushed stone, ravel, or sand)	
5 - snowy; 6 - icy	
7 - treated with anti-ice materials	
8 - with snow coast	

Lightning	Code
1 - daylight	
In dark time 2 - switched on	
3 - not switched on; 3 - absent	

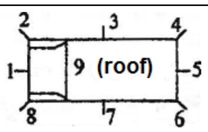
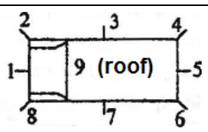
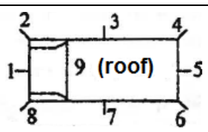
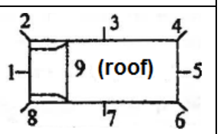
Weather conditions	Code
1 - fair weather; 2 - cloudy	
3 - fog; 4 - raining; 5 - snowing	

Contributing road conditions
01 - uneven surface; 02 - surface defects
03 - surface with low grip quality
04 - unsatisfactory status of roadsides
05 - roadside understated in relation to roadway
06 - inconsistency between dimensions of a bridge and roadway width
07 - poor visibility of traffic light
08 - malfunction of traffic light
09 - absence of horizontal road markings
10 - absence of vertical road markings
11 - trees (poles) on roadside
12 - presence of outdoor advertising
13 - absence of sidewalks
14 - absence of necessary barriers
15 - insufficient lightning
16 - malfunction of lighting
17 - narrowing of roadway (snow, etc.)
18 - snowy shafts which are limiting visibility
19 - absence of fences, alarms in places of works
20 - poor visibility of vertical traffic signs
21 - absence of vertical traffic signs
22 - improper of vertical traffic signs
23 - poor visibility of horizontal road markings
24 – limited visibility
25 - absence of speed change lane
26 - mismatch of road parameters and its category
27 - inconsistency with the requirements of a railway crossing
28 - malfunction of railway crossing alarms
29 - absence of guiding devices and light-reflective elements

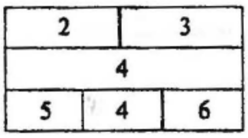
**** maximum 3 conditions***	**Code**			

Roadway width, m	
Roadside width, m	
Sidewalk width, m	
Width of separating line, m	

Section 5. Information about vehicles involved in the crash

	Vehicle № 1	Vehicle № 2	Vehicle № 3	Vehicle № 4
Vehicle escaped from the crash site: 1 - no, 2 - yes; Apprehended subsequently: 3 - within 1 day, 4 - in 1-3 days, 5 - in 3-10 days, 6 - in more than 10 days				
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Wanted vehicle	1 - no 2 - yes	1 - no 2 - yes	1 - no 2 - yes	1 - no 2 - yes
Region of registration				
State registration number				
Type of vehicle				
Brand, model				
Manufacturing plant				
Registration certificate	series	series	series	series
	number	number	number	number
Engine number				
Car body number				
Chassis number				
Year of production				
Colour (tint):	0 - white, 1 - yellow, 2 - brown, 3 - red, 4 - orange, 5 - violet, 6 - blue, 7 - green, 8 - black, 9 - other.			
	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
Position of steering and type of drive:	Steering on the left: 1 - front, 2 - rear, 3 - four-wheel Steering on the right: 4 - front, 5 - rear, 6 - four-wheel, 7 - other.			
	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Technical malfunctions	1 - braking system, 2 - trailer's braking system, 3 - steering control, 4 - exterior lights, 5 - threadbare of tire pattern, 6 - detachment of a wheel, 7 - tires mismatch to vehicle, 8 - hitch-mechanism, 9 - other.			
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Factual seating capacity at the time of crash (driver + passengers), persons				
Number of trailers, pcs.				
Location of the largest vehicle damages				
Ownership				
Type of ownership				
Organizational and legal form of business entity or ministry				
Enterprise (organization)				
Owner (physical person)				
District of registration				
Possession of a license	1 - yes 2 - no 3 - no information			
	1 2 3	1 2 3	1 2 3	1 2 3

Section 6. Participants of the crash

	Participant № 1	Participant № 2	Participant № 3	Participant № 4
Escaped from the crash site: 1 - no, 2 - yes, 3- apprehended subsequently, 4 - not apprehended				
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
	Participant category: 1 - driver, 2-6 - passenger (according to the scheme), 7 - passenger (place is not established), 8 - pedestrian, 9 - other participant			
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Sequence number of vehicle, in which the participant was at the time of crash				
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Last name				
First name				
Middle name				
Sex	male female	male female	male female	male female
Date of birth				
Severity of crash consequences: 1 - not injured, 2 - non-fatally injured, 3 - fatality				
	1 2 3	1 2 3	1 2 3	1 2 3
Place of residence (country, region, address)				
Place of work, position				
Place of service (for policemen and military servants)				
Additional information				
Social characteristic of participant: 1 - worker, 2 - office employee, 3 - military servant, 4 - pensioner, 5 - unemployed, 6 - student, 7 - entrepreneur, 8 - policeman,				
9 - other.	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Driving licence (temporary leave)	series	series	series	series
	number	number	number	number
Driving experience, years				
Time spent driving before the crash, hours				
Traffic offences (violations)*				

(See codes of offences on reverse side) * Maximum 3 violations

Traffic violations by drivers:
01 - not licensed to drive a vehicle of particular type (used at the time of the crash);
02- has no driving license; 03 - driving under influence of alcohol;
04 - exceeding speed limit; 05 - inappropriate speed for particular road conditions;
06 - driving into opposite lane; 07 - ignoring priority of another vehicle;
08 - failure to signalize or improper signalizing; 09 - blinding by headlights; 10 - wrong choice of distance;
Violations of rules for:
11 - overtaking; 12 - lane changing; 13 - towing; 14 - transportation of people; 15 - vehicle stopping and standing; 16 - passing tram stop; 17 - passing pedestrian crosswalk; 18 - loading, transporting and securing of loads; 19 - passing railway crossing; 20 - using of exterior lights;
Violations of requirements of:
21 - traffic lights; 22 - road markings; 23 - regulator's signals; 24 - vertical traffic signs;
25 - standing on dark roadway or roadside; 26 - driving vehicle with technical malfunctions;
27 - driving unregistered vehicle; 28 - other traffic violations
62 - violation of permissible norms for tinting of car glasses
Traffic violations by pedestrians:
31 - crossing road outside pedestrian crosswalk;
32 - crossing road at improper place; 33 - ignoring traffic lights (or regulator's signals);
34 - unexpected appearance from behind moving vehicle; 35 - unexpected appearance from behind standing vehicle; 36 - unexpected appearance from behind buildings (trees); 37 - walking on road in presence of sidewalk; 38 - walking in roadway along the direction of traffic outside settlement area;
39 - playing on roadway; 40 - pedestrian aged below 7 years without adult;
41 - alcoholic intoxication; 42 - other traffic violations.

Section 7. Additional information (first, second, last names and diagnoses of casualties, hospitals of admission)

1st participant

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2nd participant

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____
____

3rd participant

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____
____
____

4th participant

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____
____
____

Notation:
The first copy of the form is to be submitted to the STSI[a] of the MIA[a] of the subject (region) of the Russian Federation within no more than 3 days.
The duplicate copy of the form is to be stored at the subdivision of the STSI for the city or district of the crash for two years (order № 328 of the MIA of the Russian Federation).

The form is filled in by _________________ _______

Date_______________ № in BRC[c] ________________

Date_______________ № in JRI[d] ________________

Chief of the STSI subdivision

____

[a] State Traffic Safety Inspectorate; [b] Ministry of Internal Affairs;
[c] Book for Registration of Crimes; [d] Journal for Registration of Information

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