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Distinguishing traffic modes in analysing road safety development

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ABSTRACT

Changes in mobility influence road safety. The effects of safety measures may even be overshadowed by the effects of temporary mobility fluctuations. Usually mobility is corrected for by defining risk as the ratio between fatalities and mobility. Due to lack of sufficient data, mobility is often approximated by car mobility. In this paper we will show that the resulting “general” risk is misleading. Stratification by traffic mode shows that the risk for car drivers, motorcyclists and truck drivers is roughly constant between 1950 and 1970 and that it has been decreasing exponentially afterwards. This contradicts the development of general risk, which has been decreasing the whole period between 1950 and today. Further stratification shows that stratification by traffic mode of the fatality alone is still insufficient. Changes in mobility of the other party in a crash are also important. The development of risk of car–car accidents differs significantly from that of single vehicle car accidents. A comparison between single vehicle motorcycle accidents and motorcycle–car accidents shows a similar discrepancy. Stratification of mobility by traffic mode, and of fatality data by the relevant traffic modes involved, can enhance the understanding of the influence of mobility on safety.

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1. Introduction

An accurate understanding of the influence of mobility on road safety is required to model the influence of safety measures on the number of fatalities. This is because the effects of each separate safety measure usually only gradually influence a small fraction of all fatalities, whereas mobility changes may be sudden and substantial.

Several authors (e.g. Oppe, 1991) have studied the total number of traffic fatalities in combination with mobility. Many countries have known a period with a strong increase in the total number of traffic fatalities, whereas afterwards a decrease suddenly set in. This often resulted in a cusp-like development of the number of fatalities (OECD, 2006). Researchers tried to explain this phenomenon by a simultaneous increase in mobility and a decrease in risk. Oppe calculated risk as the ratio between all fatalities and traffic volume (vehicle kilometres). Other authors have used a similar approach, using a generic measure of mobility, either car (i.e. passenger car) distance travelled or total (motorized) traffic (Broughton et al., 2000), or any approximation for this such as fuel consumption (Fournier and Simard, 2002). Oppe found that a simultaneously exponentially decaying risk and an S-shaped increasing mobility explain the cusp-like trend in the number of fatalities in six countries reasonably well. This approach is acceptable, but not accurate. His approach explains the rough form of the cusp in the number of fatalities, but smaller variations and the recent slow down of the risk decay were not explained. A thorough understanding of this phenomenon is still lacking, as Gaudry (Gaudry, 1997) mentioned.

The disadvantage of the above methods is that a general measure (e.g. car mobility or total motor vehicle mobility) for mobility was used to take into account the influence of mobility on road safety. Mobility of each modality should be taken into account when analysing or modelling road safety. This is because some modalities bear a higher risk than others (e.g. motorized two wheelers). The purpose of this study is to analyse mobility and its influence on road safety. The authors show that a general measure for mobility is not sufficient. We searched for better ways to take into account the development of mobility. Not only car mobility or total mobility was included, but mobility of each modality. This method is more complex because it involves a distinction between different traffic modes, as well as between single vehicle and multivehicle accidents.

The focus of the paper will be on understanding rather than on modelling road safety data. Such understanding of the influence of mobility on safety is a first necessary step in modelling road safety development, before models can be made for safety measures. To develop an accurate functional form for any model that describes

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the influence of mobility on road safety, we consider it necessary to gain insight in their relation. Without this insight, models may be inaccurate, such that changes in the number of fatalities due to changes in mobility may obscure the effect of safety measures. Therefore, the paper will not discuss calculations of parameters of models. Furthermore, we will not give a detailed description of the effects of safety measures. Instead, we will demonstrate the importance of mobility changes by stratification of fatalities and mobility by traffic mode. Not only is the mobility of the traffic mode of the victims important, also the mobility of the traffic mode of the other parties has a large influence on the number of accidents.

As we wanted to include a period with both changes in the increase/decrease of fatalities and mobility in our analysis, we decided to study a 50-year period from 1950 to 2000. Following Gaudry's suggestion, we think that the cusp in the 1970s offers an important opportunity to understand road safety development. In this study, Dutch data was analysed because of its accessibility for the authors. However, these analyses can be applied to data of any country if available. The choice of data and its stratification level are discussed in Sections 2, 5 and 8.

We start in Section 3 with looking at the total number of fatalities divided by one measure of mobility, in this case car mobility. We will call this ratio the general risk. This is an accepted method to take into account the effects of mobility. In Section 4 we will show the shortcomings of such overall approach, in which all fatalities are explained by just one mobility measure. We demonstrate that an understanding of the influence of mobility on the development of fatalities since 1950 cannot be based on car mobility only.

In Section 6 we will first distinguish between fatalities of different traffic modes. We will limit our analysis to the three traffic modes for which we have mobility data since 1950: car, motorcycle and truck. We will show how the risk of a fatal accident, for drivers of these traffic modes, developed over time. The analysis reveals that the influence of changes in traffic volume is very strong, and contradictory to the common belief that the risk decreased over the entire period between 1950 and today.

In Section 7 we will show it is necessary to make a further step towards traffic mode separation. The mobility of the other party also plays an important role. We have to distinguish between different fatality types such as single vehicle accidents (no other party involved), and accidents between two traffic modes. In Section 8 we will further stratify the accident data on fatality type. We will separate accidents with car or motorcycle only (single vehicle accidents) and accidents with two cars, or with both a car and a motorcycle. In Section 9 it is shown that the risk for these six fatality types developed differently.

In Section 10 we will discuss the results. We will give possible explanations, and indicate the direction into which we want to continue our research.

2. Data (totals)

Two types of data are necessary for analysing road safety development, namely accident data and mobility data. To begin with the total number of fatalities and the passenger car mobility were used.

2.1. The total number of fatalities

For all data about fatalities, we used the digitally available accident record data of the Ministry of Transport (AVV/SWOV, 1976–2006) since 1976, and for the period between 1950 and 1976 we used CBS' tables (e.g. CBS, 1950).

The data is based on the police accident registration. Since 1993, police registration data is compared with municipal administration of causes of unnatural death and with court records. This has revealed that underreporting of police fatality data is about 7%. In this analysis we use the police records, and not the higher factual numbers. It is not possible to use the factual numbers in analyses, as there is no additional information available about the accidents that are missing from the police records. Furthermore, these actual numbers are not known before 1993.

In the Netherlands, road fatalities are defined as those involved in a road crash who die of their injuries within 30 days after the crash. A road crash is defined as an accident on a public road, involving at least one vehicle (not necessarily a motorized vehicle). Accidents involving pedestrians only are not considered a traffic accident, but a single vehicle bicycle accident is.

The reported numbers of fatalities in the Netherlands since 1950 are shown in Fig. 1. This figure shows that the numbers of fatalities between 1950 and 1970 have increased strongly. This increase appears to be approximately exponential. This is visualized in the right panel of the figure, where a logarithmic vertical axis is used. Therefore, each exponential increase and decrease is shown as a straight line. Around 1970, this exponential increase stops, and from 1972 onward, the number of fatalities decreases almost as strongly as it increased before 1970. After 1985, the decrease lessens. We did simple, unweighted exponential lines of constant annual change to estimate the exponential increases and decreases in the three periods. The exponential slopes β of these lines of constant annual change are used to quantitatively compare the developments in the three periods. Each β represents the slope of the log-linear function, as in $y(t) = \alpha\, e^{\beta t}$. For small values, this β is almost equal to the fractional annual change. Throughout this paper we will use the value of β as a practical indication of the annual change in percentages.

Fig. 1 shows an annual increase of approximately 5.4% before 1970, and a decrease of −5.7% afterwards (the minus sign indicates a negative slope). The decrease slows down to a present value of about −3% yearly. In the following paragraphs we will focus on the cusp near 1970, the strong change in the slope of the log-linear

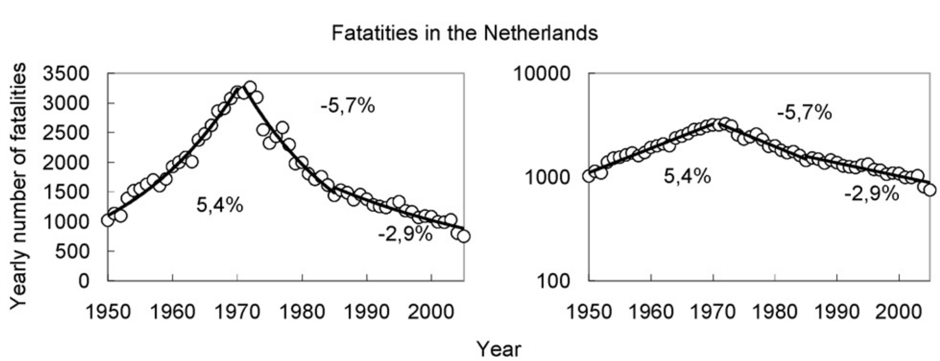

Fig. 1. Traffic fatalities in the Netherlands since 1950 with a linear (left) and a logarithmic (right) vertical scale. The solid lines are exponential lines of constant annual change for the periods 1950–1970, 1972–1985 and 1985–2005, with the annual change as a percentage.

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