POLICE RECORDING OF ROAD ACCIDENT IN-PATIENTS

Investigation into the completeness, representativity and reliability of police records of hospitalized traffic victims

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Martien W. Maas & Stephen Harris
Institute for Road Safety Research SWOV, The Netherlands

SUMMARY

The present investigation was carried out in order to establish the completeness, the representativity and reliability of police records, concerning persons injured in road accidents, who had to be hospitalized. Information in this respect is necessary because scientific road safety investigations require to an increasing extent more data which do not refer exclusively to fatalities. For this purpose the injured persons, who had to be admitted to hospital, have to be taken into consideration in the first place because - apart from fatality data - they are the most relevant for road safety. However, prior to using such data in the investigation in a responsible manner, their 'value' has te be recognized. In order to establish the usefulness of police records of these persons injured in road accidents, the police records are compared with those compiled by the Medical Record Foundation (SMR). This institution records nearly 95% of all persons hospitalized in the Netherlands.

The comparison shows that police records in 1979 contained about 83% of all hospitalized persons injured in a road accident.
Because the level of recording is not equally high for all sub-groups, it has to be concluded that police records are not representative for all hospitalized traffic victims. Thus for example, among the persons using motor vehicles, the age groups between 15 and 35 years are overrepresented, whereas the cyclists and pedestrians and children up to 14 years are underrepresented in police records.

Since the pattern of overrepresentation and underrepresentation remains about the same during several years, the police recording of hospitalized traffic victims can be regarded as a reliable (i.e. stable) mode of recording. For this reason police records can be used in following the trend in the number of these traffic victims.

ABSTRACT

Many road safety research projects make use of the official police road accident data. Their use is often restricted to the data on fatal accidents and fatalities because it is the only complete registration, and the extent of underreporting of injury accidents is unknown. The need to extend the use of data beyond fatalities is great for two reasons:

1. In a small country like the Netherlands the absolute numbers (less than 2000 fatalities per annum in recent years) are often too small for detailed analyses.
2. Fatal accidents are not typical road accidents but an extreme type. Data on surviving in-patients however, is not so extreme and there are more than 20,000 per annum.

The incomplete police data on road accident in-patients was compared with the hospital discharge data to establish how representative it was. Hospital data was collected through the Medical Record Foundation, a national institution, which registers approx. 95% of all road accident in-patients.

During the years 1977-79 it was found that the extent of underreporting was constant and for the year 1979 the police data had a coverage of 83% of all road accident in-patients.

According to the results of an Eckart-Young analysis, the general structures of the police and hospital data were similar but there were differences. The underreporting of users of motorized vehicles in the age group 15-34 yr was significantly smaller than for others; and of cyclists and pedestrians, particularly in the age group 0-14 yr, significantly greater.

The police data is therefore reliable for time series and for period studies of most mode of transport/age group combinations.

CONTENTS

PREFACE

The road safety investigations in the Netherlands depend to a considerable extent on statistical analyses. In order to carry them out, researchers need a great deal of reliable data at their disposal: especially accident and exposure data. Since 1963 SWOV has endeavoured to improve the recording of such data. The recommendations of SWOV for an Integral Road Accident Recording System (INVORS) undoubtedly contributed to the establishment of the Accident Records Office (VOR). VOR processes all accident reports made up by the police. These reports form the basis of the national accident figures which are published by the Central Bureau of Statistics (CBS). The 'Risk Investigation of Road Users in the Netherlands' (ROVIN) executed by SWOV gave a significant impulse to the CBS 'National Travel Survey'. This investigation has been continuously carried out since 1978, providing important data concerning the traffic exposure of the population of the Netherlands of 12 years and older. Although the compilation of data has been considerably extended and improved in the last years, researchers, policy makers and road controllers are still regularly confronted with limitations in the available basic material.

However, a further improvement of recording would involve high costs, which cannot be easily afforded in the present economic recession. For this reason SWOV tries to make a more effective use of data compiled in the existing records. The present report describes investigations into the possibilities of making an optimal use of the accident figures provided by the Central Bureau of Statistics. The CBS-data concerning persons injured in a traffic accident who had to be hospitalized, were compared with corresponding data of the Medical Record Foundation (SMR). On the basis of this comparison it was possible to detect systematic deviations occurring in the police records.

1. INTRODUCTION

Traffic accidents are recorded among other things in order to establish the damage caused by traffic and transport. The application of such accident data to investigations into road safety has, quite often, to be limited to the number of persons killed in road accidents, because it has to be assumed that the recording of persons only injured in traffic is far from complete, whereas fatal accidents are recorded for as good as 100%.

Such limitation is undesirable for at least two reasons. In the first place because traffic fatalities are not sufficiently representative of the total bodily damage caused by traffic accidents. In the second place the number of traffic fatalities is often much too small to use in breakdowns according to detailed traffic and victim criteria, as a basis of statistical calculations for establishing certain trends.

Thus, the question arises, which data concerning traffic accidents could also be used in investigations. The criteria in looking for such data are that they have to be relevant as indication of road safety and that the extent of reliability, the completeness and the representativity of such data must be known.

The category of accidents causing injuries can be subdivided according to injured persons, who had to be hospitalized or not. It can be assumed that the average injury of traffic victims, who had to be admitted to hospital, is of a more serious nature than that of persons who did not have to be admitted, and are therefore more relevant for road safety problems. It is also known that there exists a clear relationship between the severity of an accident and the chance that the accident will be recorded by the police.

Based on this the completeness, the reliability and the representativity of police recording concerning the hospitalized traffic victims have to be investigated. These aspects of the records can be studied by means of a more-or-less parallel hospital registration by the Medical Record Foundation (SMR).

The road safety data provided by the police are so important for road safety research because these records are the only source of a great

number of accident and victim characteristics on a national level. In addition, these records supply current data each month (although in the form of provisional figures).

The object of the investigation described in this report was to measure the value of police records concerning hospitalized traffic victims, in order to use these data in a responsible manner in the study of the scope and trends in this group of traffic victims.
In the first place, the report deals with the recording of traffic accidents and traffic victims by the police and by SMR, while pointing out the differences between them.

Next the completeness of police recording (level of recording) of the hospitalized traffic victims is calculated, followed by a comparison of the SMR-data with police record data, according to the month of the accident/hospitalization, province of accident/hospital, mode of transport (= category of road user), age and sex of the traffic victim.
Finally, a comparison will be given of the combined criteria: mode of transport and age.
We wish to emphasize that it was not the object of the described comparative investigation to explain the indicated differences. Nevertheless, we shall point out to what extent differences arise as a consequence of two different recording methods and/or as a consequence of differences in definitions of the concepts and criteria applied.

2. RECORDING OF TRAFFIC ACCIDENTS BY THE POLICE

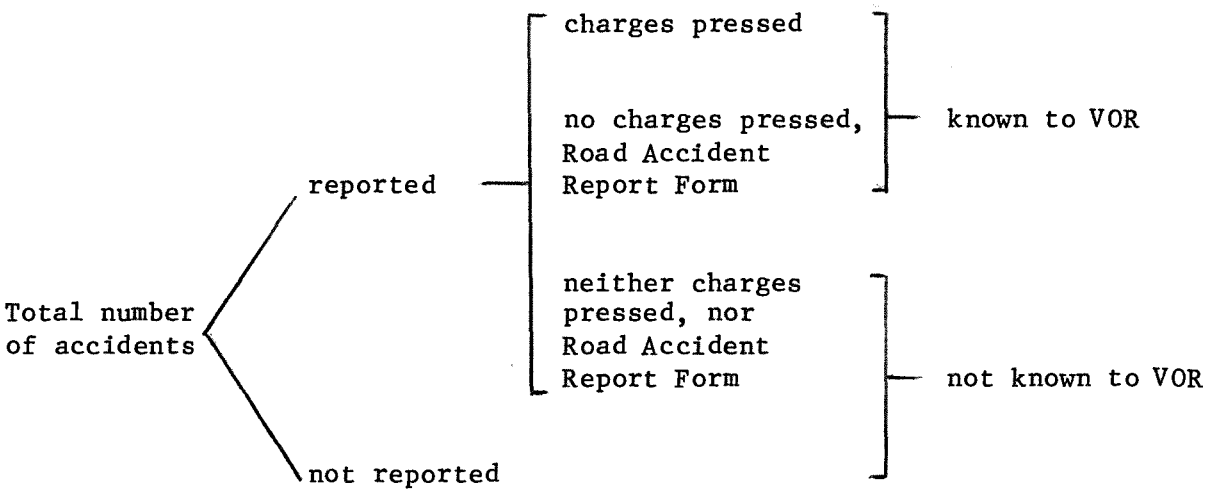
In the Netherlands traffic accidents are recorded on Road Accident Report Forms by state and municipal police authorities. In the following part of this report these bodies will be indicated by the common term 'police'.

The actual registration of traffic accident data takes place in following phases: recording by the police; processing of the accident forms by the Road Accident Records Office (VOR), while the national traffic accident figures are published by the Central Bureau of Statistics (CBS).

One of the victim characteristics recorded by the police on the Report Form is whether or not he/she was admitted to hospital, and if so the name of the hospital.

As regards the factors which may play a part in the procedures of the charging and recording by the police we refer to a report by the Scientific Investigation and Documentation Centre (WODC) of the Ministry of Justice. This report comprises the results of annual investigations into the scope and type of petty offences in the Netherlands, the willingness of the population to report offences to the police and the charge policy as followed by the police.
In the investigation concerning accidents, carried out in the form of a survey (the so called 'victim survey'), the police also asks among other things about the involvement of the interviewed person in road accidents. Furthermore, they were also asked whether the accident was reported to the police and in case of a positive reply, whether charges were pressed (WODC, 1979).
The published results do not provide an unambiguous evaluation of the scope of traffic accident phenomena in the Netherlands, because of the limited nature of the enquiry (the respondent must not have been guilty regarding the accident; single-vehicle accidents were not included in the enquiry), and because of the sample being limited to persons aged 16 years or older. The investigation is primarily directed to victims of an offence or a crime. Thus for example the question about the involvement in a collision is followed by another one, which is of greater importance for the judicial aspects of the investigation: "did the person causing

the collision drive on after the collision without identifying himself?" This namely is a punishable offence. The reports of the WODC note the willingness of the public to report collisions to the police. Thus the WODC report emphasizes the committed offences. However, several factors which are of importance in the administrative procedure of reporting and recording offences also play a part in the recording of traffic accidents involving bodily injuries and/or material damage. In the guidelines for charging in case of collisions, the section 'Reporting for statistical purposes' contains the following: 'The police have to report to CBS all road accidents they are notified of, thus, both road accidents caused by collisions and road accidents caused by other factors, in as much as said accidents caused the death or injury of one or more persons'.
For the sake of completeness it has to be observed that in the meantime this rule has been modified: accidents have now to be reported to VOR instead of to CBS, since VOR has been entrusted with the processing of all Road Accident Report Forms.
The following schematic representation of the compilation of road accident statistics has been taken from WODC (1979) and the aforementioned guidelines:



The given scheme indicates the 'filters' a road accident has to pass through prior to being included in the road accident statistics. In this connection, the problem not only involves the relationship between the total number of actual accidents and the number of the finally recorded

accidents, but also the question whether this relationship is constant or not.

In relation with the given scheme we can draw the following four conclusions from the WODC report:

1. The decision to report an accident or not depends in the first place on the severity of the accident as measured by the extent of material damage and/or the severity of the injury.
2. In drawing up their charge report, the police apply some kind of selection. The decision to press charges or not depends mostly on the seriousness of the offence.
3. In the reporting of offences involving a severe injury, the fact that somebody suffered an injury (treated by a physician or first-aid personnel) seems a sufficient reason for pressing charges.
4. There is a certain interaction between the dismissal policy of the Office of the Public Prosecutor, the charge policy of the police, and the willingness of the public to report offences to the police.

The problem of the registration of injury accidents is a result of the police not knowing about them all. One has the impression that people witnessing an accident with one or more injured persons will be inclined to call in medical aid only or, at least, in the first place. Whether the police will be informed later on depends on whether this is important for the person(s) involved in the accident. Moreover, there seems to be a relationship between the conditions of an accident (question of guilt, extent of material damage, severity of the injuries, age of victims, etc.) and the attitude of the public with regard to informing the police or not. Thus for example, it is possible that in cases where the injured person is quite evidently responsible for the accident, without any appreciable damage to other involved traffic participants, the public will not be very eager to notify the police of the accident.
Although, according to the guidelines, all accidents involving injuries have to be reported to VOR, the recording level of serious road accidents will certainly be higher than that of less serious ones. The reason for this is that the public is more ready to report accidents with serious injuries to the police and moreover, that in such cases the police will be more inclined to charge and/or report to VOR.

From the data of the WODC investigations carried out in 1976 en 1977 (WODC, 1979) it becomes evident that about 48% of the persons, who were involved in a collision while being in no way responsible for it, reported it to the police. In about 61% of these reported collisions, the police pressed charges. Another figure, obtained from an as yet unpublished survey, carried out by SWOV in 1976, indicates that the police was present in about 45% of all accidents involving injuries. In other words, however, this means that more than half of all accidents involving injuries was not recorded. The measure of incompleteness due the present police procedures (charging and recording), some aspects of which have been discussed in this chapter, is certainly higher still.

Based on the foregoing considerations, it can also be assumed that the recording level of traffic victims, who had to be hospitalized, will be higher than that of those who were not admitted to a hospital. This issue will be discussed in detail in Section 5.

3. RECORDING OF TRAFFIC VICTIMS BY THE MEDICAL RECORD FOUNDATION (SMR)

3.1. The scope of recording

The Medical Record Foundation (SMR) is a centre of information processing for hospitals in the Netherlands, which was established in 1963. Hospitals take part in this recording system on a voluntary basis. Since 1977 more than 90% of all Netherlands hospitals (general hospitals) send their data to this centre.
The data supplied by the National Institute of Hospitals (NZI) show that about 94% of all hospitalizations in Dutch hospitals are recorded by SMR. According to SMR, the summarized data supplied by the participating hospitals give satisfactory insight into the clinical health service on a national level (SMR, 1981). We assume that SMR records ca. 95% of the road accident victims, who had to be admitted to hospital.

3.2. Mode of processing in the hospital

SMR aims at collecting and processing the data obtained from hospitals. Since a great number of data can be used for various purposes, the centre endeavours to record all data once, in a way that they can be used for all purposes. SMR processes both the medical and administrative data of hospitalized persons. For the work of SWOV the coding on injuries (sphere of interest: crash and post-crash investigations) and the coding of so-called external causes of injury are of interest. The latter coding uses the International Classification of Diseases (ICD) of the World Health Organization and establishes whether the hospitalization of a patient was necessary as a result of a traffic accident, this coding also supplying information over the mode of transport.

The hospital works as follows. On hospitalization a record is made for every patient, containing the personal data (name, address, etc.) on the Discharge Form, which is kept in the medical file of the patient or in the medical administration department.
The consulting physician enters the medical data: diagnosis (diagnoses), operation(s), complication(s), mode of discharge, etc. The completed Discharge Form contains all data which are necessary for filling in the

punch card: the so-called 'Hospitalization/Epicrisis Report'. The coding of diagnoses, operations, etc. is done by the medical administration department.

Thus, the source of all information is the consultant physician authorizing the discharge of the patient. The interpretation of the circumstances of the accident as entered into the Discharge Form is the task of a trained recording assistant in the medical administration department. We can assume that the circumstances of the accident and the external cause of injuries resulting (in casu: the mode of transport) will not be the most essential data on the Discharge Form, because the system is designed for medical recording and not particularly for the recording of traffic accidents. For this reason the mode of transport of some of the accident victims is unknown. In 1979 their number was 1,425 out of a total of 22,201 (i.e. 6.4%).

In comparing the SMR-figures with the police data relating to hospitalized injured persons, broken down according to various modes of transport (see Sections 6 and 7), this relatively high number of unknown persons can give a somewhat distorted picture. It is not possible to correct in a responsible manner the classification of unknown injured persons according to the mode of transport. However, in the interpretation of the found differences this circumstance has to be taken into consideration.

4. DIFFERENCES IN DEFINITIONS USED BY SMR AND THE POLICE

An essential difference between the two systems is that the police records persons, whereas SMR records hospitalizations.
In the case of a traffic victim being hospitalized twice in two different SMR hospitals as a result of one accident, this will result in the recording of two hospitalizations. There are no data available in the SMR-records concerning double hospitalizations. On the other hand, SMR will record those patients who, after treatment, had been transferred into another medical-therapeutical institution. However, these transfer data do not reveal whether the patient was transferred into a rehabilitation centre (for example a long-stay institution, not included in the SMR recording system) or into another general hospital. Neither do they indicate whether the 'receiving' institution participates in the SMR recording system or not.
In 1979, the number of patients who, after being discharged from a hospital, were released into a medical-therapeutical institution, was about 3.5% of the total number of discharged patients. Based on this figure, the number of double hospitalizations cannot be more than about 3.5% of the total number of hospitalizations. The data in Table 1 show that this percentage is considerably higher (5.1%) for persons using motor vehicles than for those not (2.3%).

This difference could be explained by the fact that accidents involving motor vehicles as a rule occur at greater distances from the dwelling place of the persons involved. If a traffic victim has to be hospitalized this will nearly always take place in a hospital in the proximity of the place of accident. As soon as the patient is sufficiently recovered he can be transferred into another hospital in the neighbourhood of his home. This, of course, leads to double hospitalization in the SMR recording system.
Since the number of double hospitalizations cannot be established, it is not possible to correct the related SMR figures. However, these double hospitalizations have to be taken into account in the interpretation of the results of various calculations.

Another essential difference between the data of SMR and that of the police is caused by the SMR definition of road accidents. The police records only those accidents which occurred on public roads, while (up to 1979) the SMR system made no distinction between accidents on public roads and 'other road accidents'. Thus, for example, SMR recorded accidents, which occurred on private grounds (factories, racing tracks, etc.) as 'traffic accidents'. An indication in the SMR records of the number of traffic victims injured in accidents on such places, can be obtained from the SMR figures for 1980. Since 1980 SMR makes a distinction between accidents occurring on public and other types of roads. The 1980 figures indicate that 2.8% of the hospitalized persons was injured in accidents not occurring on public roads. For most modes of transport the corresponding percentage is somewhere between 1 and 3. The group of hospitalized motorcyclists (incl. pillion riders) is an exceptional one: about 14% of these accident victims were involved in nonpublic road accidents.

Since these data only refer to one year (1980) they will not be corrected in Sections 6 and 7, although they must be taken into consideration in the interpretation of results. In evaluating the completeness of police records (Section 5), a 3% correction with regard to the SMR-figures will be applied.

Traffic victims, who died more than 30 days after the accident, are entered in the Central Bureau of Statistics records as persons injured in traffic accidents. In case, however, these victims died in a hospital belonging to the SMR record system, they will be recorded here as fatalities. For this reason, on evaluating the completeness of police records (Section 5), a correction has to be applied to the SMR figures (see also SWOV, 1979). The SMR tables used by SWOV show that in the period 1976-79 246 traffic victims died 31 or more days after hospitalization, while 95,161 persons were discharged alive. For the calculations in Section 5 a correction of 0.25% has been applied. In Sections 6 and 7 no corrections could be applied in this respect.

5. THE COMPLETENESS OF POLICE RECORDS

The completeness of police records is established as follows.
In the first place the SMR figure of traffic victims who died more than 30 days after the accident has to be corrected: + 0.25%.
The following correction relates to a reduction of the SMR figure, because (in contrast with CBS figures), this figure includes persons, injured in accidents occurring on non-public roads: - 3%.
Next the SMR figure is increased to a national level on the basis of the SMR share (of hospitalizations) in all Dutch hospitals: varies per year.
The level of police records of traffic victims (injured persons) who have been admitted to a hospital can now be established by relating the CBS figure to that one, which had been calculated on the basis of the SMR records. The police record level thus obtained can be regarded as a kind of lower limit, since the increased SMR total figure contains an unknown number of double hospitalizations (certainly not more than 3.5%) which exaggerates to some extent this total figure, thereby leading to a slight under-estimation of the police record level.

Table 2 contains the results of completeness in calculations relating to the years 1976-79. In 1979 the level of police records of hospitalized persons, injured in traffic accidents, was 83%, thus slightly lower than in 1978 but a fraction higher than in 1976 and 1977.
Thus, the police recording of traffic victims (injured persons) admitted to hospital is more complete than that of the rest of traffic victims.
The level of police recording of <u>all</u> traffic victims is estimated to be considerably below 45% (see Section 2).

6. DETAILED COMPARISON BETWEEN THE POLICE DATA AND THE SMR-DATA

SWOV obtains yearly a standard packet of tables from SMR, in which the traffic victims (including those who died in hospital) are broken down according to diagnoses (cause of hospitalization); the mode of transport; sex; age; sustained injuries; mode of discharge from hospital; month and time of hospitalization; the province (of the hospital).
For a comparison between the CBS figures and the SMR figures, SWOV commissioned SMR to produce an additional table relating to 1979 and containing data over surviving discharged traffic victims, according to the mode of transport and age. This table will be discussed in Section 6.
SWOV also obtains a tape and an extensive packet of tables from CBS, which are based on recording forms, filled in by the police and processed by VOR.

However, the CBS and SMR figures can only be compared on the basis of variables included in both recording systems.
In this Section we shall discuss a number of uni-variate comparisons between CBS and SMR figures, the data having been broken down according to month, province, mode of transport, age and sex.

6.1. Month

A variable, common to both recording systems, is the month. However, the practical meaning of this variable is not the same in both systems: the month, published by CBS is the month in which the accident took place, while for the SMR it is the month in which the traffic victim was admitted to a hospital.

An additional problem implied in the SMR-data is the fact that the tables covering a year only relate to patients who had been discharged from the hospital in the given year. For example, patients who had been hospitalized in December 1978 en discharged in 1979 are included in the tables of 1979, with December as the month of admittance. The problem here is that patients hospitalized and discharged in December 1979 will figure in the SMR table precisely in the same manner.

Furthermore, the month of admittance to hospital and the month of the accident can be different, for example in case of accidents occurring towards the end of a month. However, it can be assumed that such deviations are of a rather stable character, thus having only a weak influence on the distribution over several months.

Table 3 contains comparisons between CBS figures and SMR figures for the years 1976-79, wherein for the sake of clarity the data are grouped per quarter. It was found that the differences between the quarterly ratios (CBS figure divided by the SMR figure) are not very considerable.
In the years 1976-78 the ratios for the first and fourth quarter seem to be slightly higher than those for the second and third quarter. However, the ratio for the first quarter of 1979 is not higher than those for the second and third quarter of that year, most probably due to the extreme weather conditions in the first months of 1979.

6.2. Province

Both the CBS records and the SMR records include the criterium: province. However, this criterium has different practical interpretations in each system. CBS records the province, where the accident occurred, while SMR records the province of the hospital the traffic victim has been admitted to. Of course, the province of the accident and that of the hospital can be different. In addition, the choice of hospital depends among other things on the severity and type of injury and the home of the victim.

Table 4 shows that the CBS/SMR ratios in various provinces fluctuate quite considerably: between 0.66 and 1.17. Another complication with regard to the criterium province is that the recording level of SMR differs quite significantly in the various provinces. For illustration we added to Table 4 a column published by SMR, indicating (per province) the share of participation of hospitals in the SMR recording system.
In general it can be accepted that with exceptions the higher the share of participation in the SMR recording system, the lower will be the CBS/SMR ratio.

6.3. Mode of transport

Table 5 refers to hospitalized traffic victims broken down according to the mode of transport.
This table shows that in all three years 1977-79 the CBS/SMR ratios, and therefore the police completeness, for cars and mopeds are higher than for motorcycles, bicycles and pedestrians.
The lower ratio for motorcycles can be explained by the fact that the SMR-records include a considerable number of motorcyclists, who were injured in accidents on private grounds: about 14% (see also Section 4).

An explanation of the lower ratio for cyclists and pedestrians can be found in the WODC report (1979), which has been mentioned earlier. It is known that motorized vehicles and mopeds have to be insured against third-party risks. From the WODC report it appears that insurance companies often require (prior to paying out claims) that the accident should be reported to the police by the aggrieved party. In the case of cyclists and pedestrians this requirement does not apply.
Another explanation for the low cyclists and pedestrians ratios is that children are overrepresented in these modes of transport: the CBS/SMR ratio for children is lower than that for other age categories (see para. 6.4.).

6.4. Age

Table 6 contains the breakdown of hospitalized traffic victims during 1977-79 according to five age categories.
A remarkable feature in this table is the low CBS/SMR ratio, and therefore low police completeness, for the age category 0-14 years. Higher ratios can be found for the age categories 20-34 years and 15-19 years, in each of the three years (1977-79).

In addition, we cite here the following lines from the police guidelines: "It can repeatedly occur that, for example, aged persons or children cause a collision through their own carelessness, thereby being the only victims, who sustained injury. In such a case the public prosecutor will bring no action against the person in question (the charge will be dis-

missed). Also, in such cases it seems to be justified to depart from the guideline which requires that for each collision causing an injury of some importance charges have to be pressed."
Thus, the police do not have to make up a report on such kinds of collisions. This implies that the number of police records on accidents, which they have to submit to VOR, will be reduced. It is also evident that the public will be less eager to report such collisions to the police, so that the police will have no information of them at all and will consequently not record them.

6.5. Sex

The sex of the traffic victim is the last variable common to both recording systems. Table 7 shows a slightly higher CBS/SMR ratio for men than for women in 1979.

6.6. The representativity and reliability of police records

According to the present report, the police records are considered to be representative if the recording level of the total number of traffic victims admitted to a hospital is found in each sub-group.
Based on the various comparisons between the CBS and SMR breakdowns, discussed in the preceding sections, it can be concluded that the police records concerning hospitalized traffic victims (injured persons) is not representative. On analysing the mode of transport and the age of victims, the following data will attract our attention: in the police records the participants in the motorized traffic and (consequently) the victims in the age categories 20-34 years and 15-19 years are overrepresented, while cyclists and pedestrians and mainly the victims in the age categories 0-14 years are underrepresented.

Within the scope of the present report the police records of hospitalized persons can be accepted as reliable if the breakdowns according to various criteria display each year the same deviations from the (estimated) actual breakdowns.
The results of comparisons discussed in the preceding sections lead to the conclusion that police records can be regarded as reliable (stable).

7. ANALYSIS OF MODE OF TRANSPORT AND AGE

In addition to the uni-variate comparisons described in the preceding chapter, in this chapter a comparison will be made between a CBS table and an SMR table, each of them broken down according to the mode of transport and the age of the hospitalized victims. Thus, this will be a comparison between Tables 8 and 9 containing data for 1979.

7.1. Choice and execution of the analysis method

The most direct manner of comparing both tables with one another consists of comparing the values of each item separately and looking for the differences. For this purpose we could use the CBS/SMR ratios similarly to the method applied in the preceding chapter. The ratios resulting from the Tables 8 and 9 appear in Table 10. However, it is rather complicated to make distinction between random differences and systematic ones, therefore Table 10 will not be analysed.
A more suitable manner of comparison consists of taking the structure of each table (8 and 9) as a whole into consideration. In other words: we have to find out the differences between both tables as regards the description of items in relation to the row and column structure of the data. Should there be systematic differences between the frequencies of both tables, it can be assumed that these differences are related to the structure. Therefore we have chosen an analysis programme, determining the basic structure of each table, whereafter these structures can be compared. In the present case, we decided to use the Eckart-Young analysis. The assumption behind this analysis is that there exists a relationship between the mode of transport and the age of the traffic victims.

We shall assume both tables to be a combination of several tables, each of which indicating special aspects of the relationship between age and mode of transport. The aim was to describe the SMR table and the CBS table separately as a combination of several basic tables. Next, the descriptions of both tables have to be compared with one another in order to establish the conformities and the differences. We can expect that conformities will outnumber differences and that both descriptions will be of an interpretative character.

The programme provides only a structure which is the most simple as regards mathematics. Whether it will permit a meaningful interpretation has to be determined afterwards.
It has also to be assumed that the separate tables are of a simple structure as well, to which the independence-assumption can be adapted, which is also applicable to the usual χ^2-test.

From the technical point of view the description of tables 8 and 9 solves a so-called 'singular-value decomposition' problem, as represented in the Appendix. This decomposition supplies the basic tables, furthermore a 'characteristic root', which indicates the importance of the basic table as a whole. The square of the characteristic root corresponds to the amount of explained variance in the entire table.
In addition, the decomposition for each basic table also provides a 'left and right characteristic vector', actually a curve for age and a curve for the mode of transport. These curves explain the basic table.
The value of each cell-item is the result of the product of the values of the related row and column, multiplied by the related characteristic root. Thus, there is an analogy with an χ^2-analysis.

7.2. Results of the Eckart-Young analysis

The first four characteristic roots of the analysis of the CBS table amount to 3481.30; 1831.82; 1064.16; 418.66, while those of the SMR data amount to 3563.34; 1769.77; 1222.00; 365.44. The differences are not large and thus there is no reason to assume a different structure in data only on the basis of these values.
On analysing the curve relating to the first characteristic root (Figure 1), we find that the shape of both records is nearly identical, both as regards mo?pde of transport and age. Furthermore, we find both in the CBS and the SMR data a relatively high number of injured car occupants and mopedists in the age category of 15-24 years.
According to the graphs related to the second characteristic root (Figure 2) most of the injured mopedists belong to the age category of 15-19 years, while most of the injured car occupants belong to the age category of 20-24 years.

The graphs related to the third characteristic root (Figure 3) indicate the highest number of injured cyclists and pedestrians in the age categories under 15 and over 60 years.
The graphs related to the fourth characteristic root (Figure 4) permit a still more refined classification of young cyclists, indicating especially the age group 10-14 years, and as regards young pedestrians the group under 10 years.

Although both recording systems are similar in view of their structure, there still exist some differences. Figure 1 shows relatively more injured mopedists in the CBS records and less injured cyclists and pedestrians than in the SMR records. According to Figure 1 there are also less injured persons in the 5-14 years age category in the CBS records, while Figure 2 suggests that the difference concerning this age category is linked with the differences observed among cyclists, pedestrians and mopedists. These findings are supported by Figures 3 and 4.

From the discussed analyses we can conclude that the differences between the recording levels of CBS and SMR are caused only to a limited extent by the specific relation between age and mode of transport. A distinct relationship could only be found in connection with the young.

8. CONCLUSIONS AND RECOMMENDATIONS

In the police records of the traffic victims, who had to be admitted to a hospital, the persons using motor vehicles (and injured in an accident) are overrepresented in the age categories of 20-34 years and of 15-19 years: underrepresented being the cyclists and pedestrians, mainly under 15 years. Based on these findings it can be concluded that the police records of persons injured in traffic and admitted to a hospital are not representative with regard to the mode of transport and the age of the victims. The analysis of a CBS and a SMR table of traffic victims, broken down both according to the mode of transport and age, shows that differences in the level of recording are only to a slight extent the result of specific relationships between age and the mode of transport. The table also shows that the level of police recording is for some groups more than 95%, while for other ones less than 70%.

In view of the fact that the differences between CBS and SMR distributions ('real distributions') displayed the same pattern for every year between 1977 and 1979, the police recording of persons injured in a traffic accident and admitted to hospital can be regarded as reliable (stable). By combining this issue with the high police recording level (in 1979 about 83%) we can conclude that the CBS figures of traffic victims admitted to hospital may be used in following trends in the numbers of these traffic victims.
As regards the analysis of the CBS data according to other criteria not available in this report (such as type of road), no indications can be given as to completeness.
It seems advisable to carry out, from time to time, detailed investigations into the reliability and representativity of the police records of hospitalized persons injured in a traffic accident.
The completeness of the police records of hospitalized traffic victims should be checked annually on the basis of available SMR information.

9. APPLICATION OUTSIDE THE NETHERLANDS

The official road accident data used for research is collected in all countries by the police. Police statistics being the result of a passive recording system (road accidents have to be generally reported to the police) are by their nature incomplete and therefore probably not representative for all road accidents. Police statistics in the Netherlands are however fairly complete and representative as far as road accident in-patients are concerned. They therefore form a valuable addition to the police data on fatal accidents and road deaths.

What is true in the Netherlands is probably true to a greater or lesser extent in other developed countries and maybe in some developing countries. If this is so, many countries will be able to use their police data on road accident in-patients as a research tool. Their validity, however, does first have to be established.

While all countries can produce national police data, it may be more difficult in the case of national hospital data. According to the Medical Record Foundation here, besides the Netherlands, only the United Kingdom and Denmark have such a centralized hospital record bank. This means that most countries will have to collect the data directly from the individual hospitals or through the Ministry of Health.

There are two further conditions:

1. the police have to record whether victims are admitted into hospital, and
2. the hospitals have to record whether patients are road accident victims.

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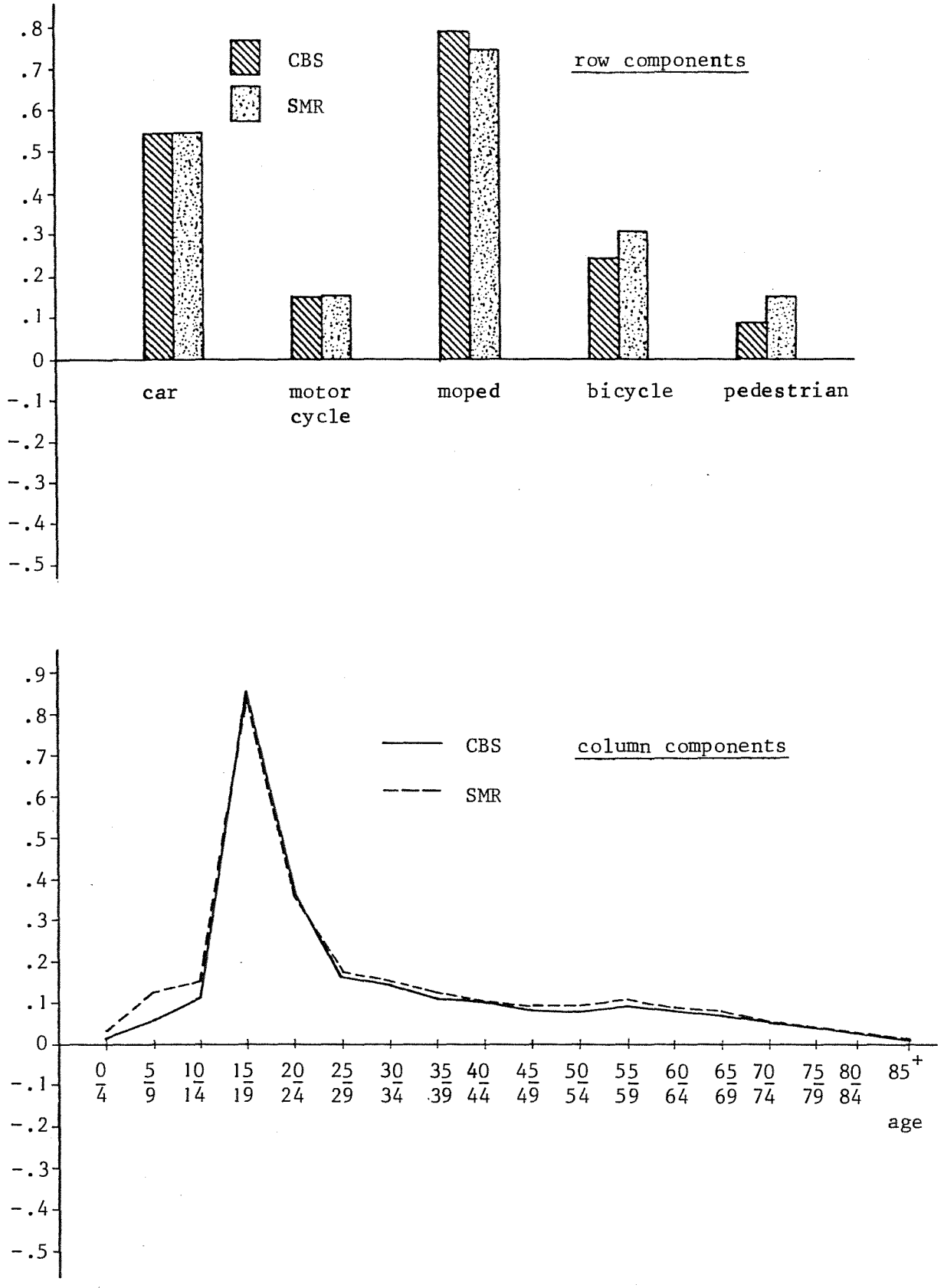


Figure 1. Eckart-Young analysis: the first characteristic root.

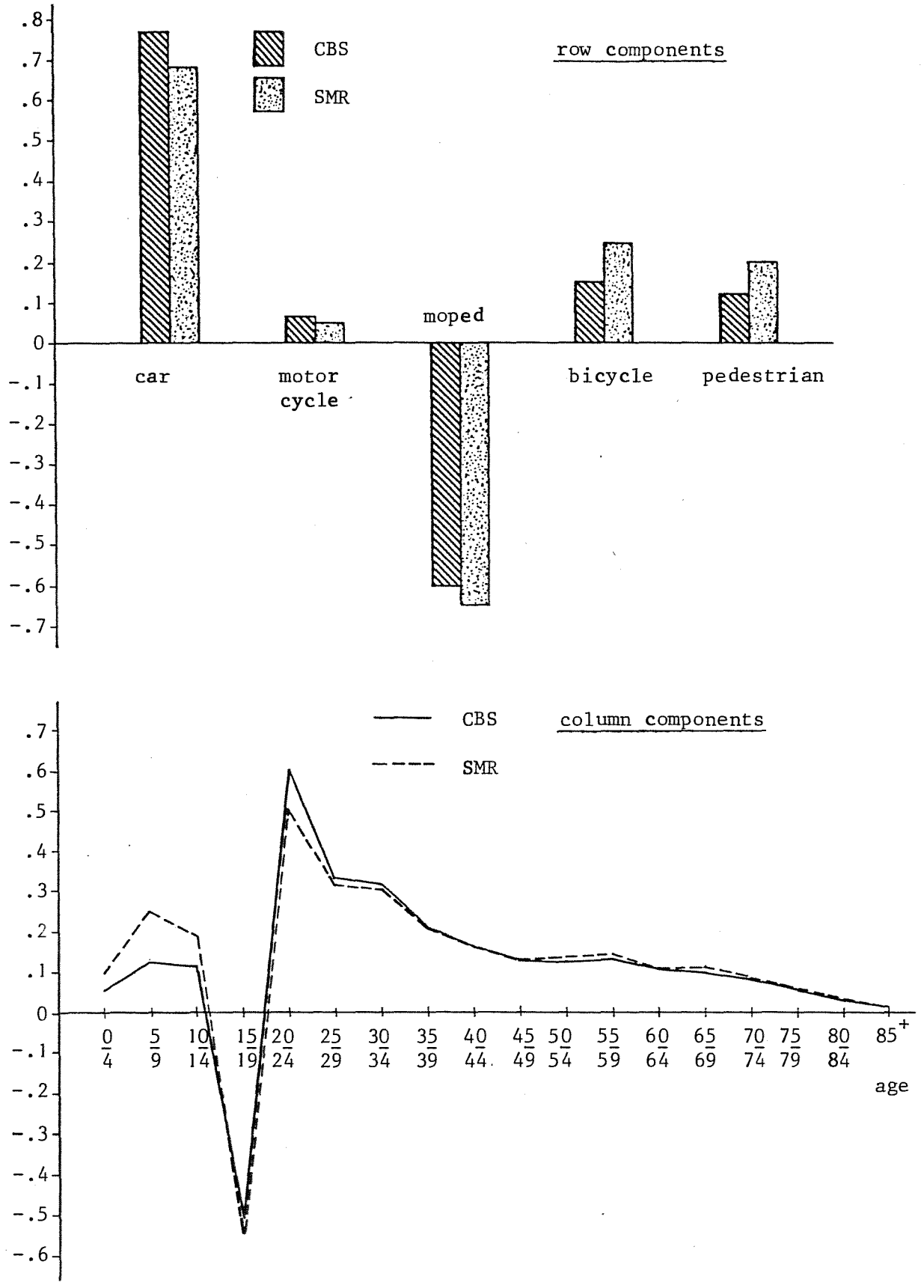
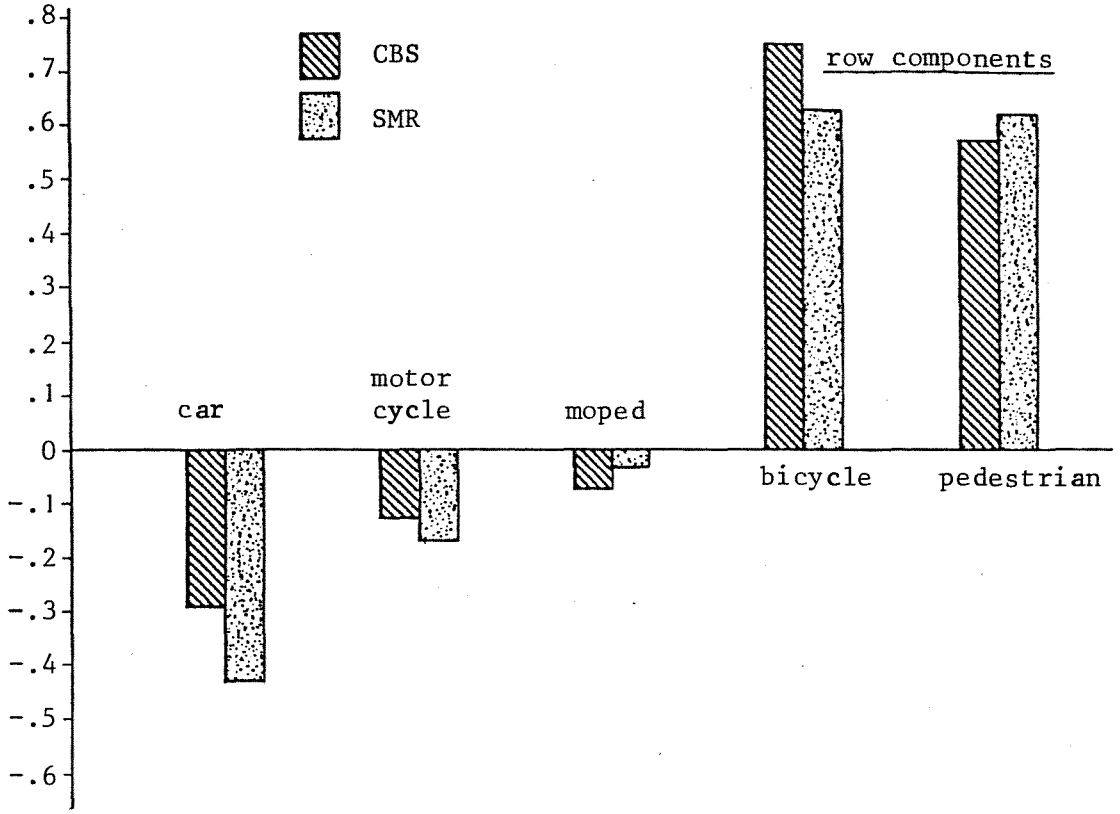


Figure 2. Eckart-Young analysis: the second characteristic root.



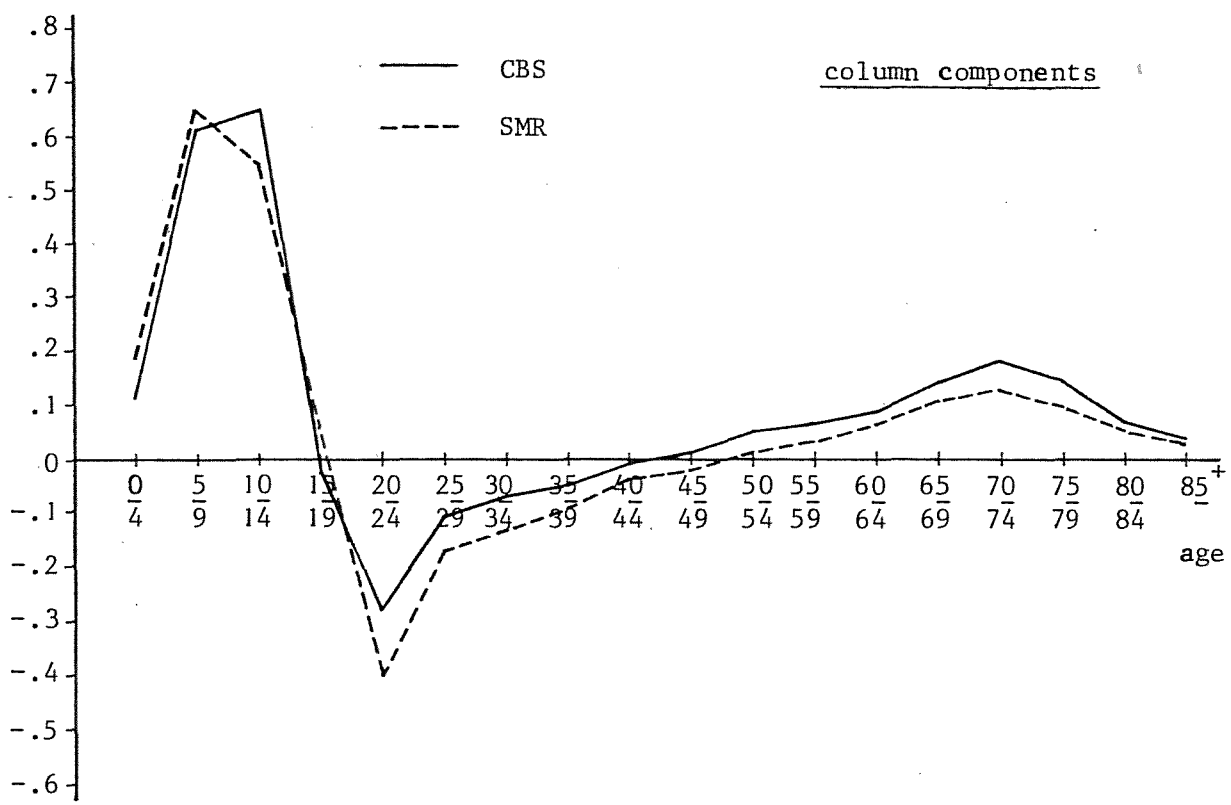


Figure 3. Eckart-Young analysis: the third characteristic root.

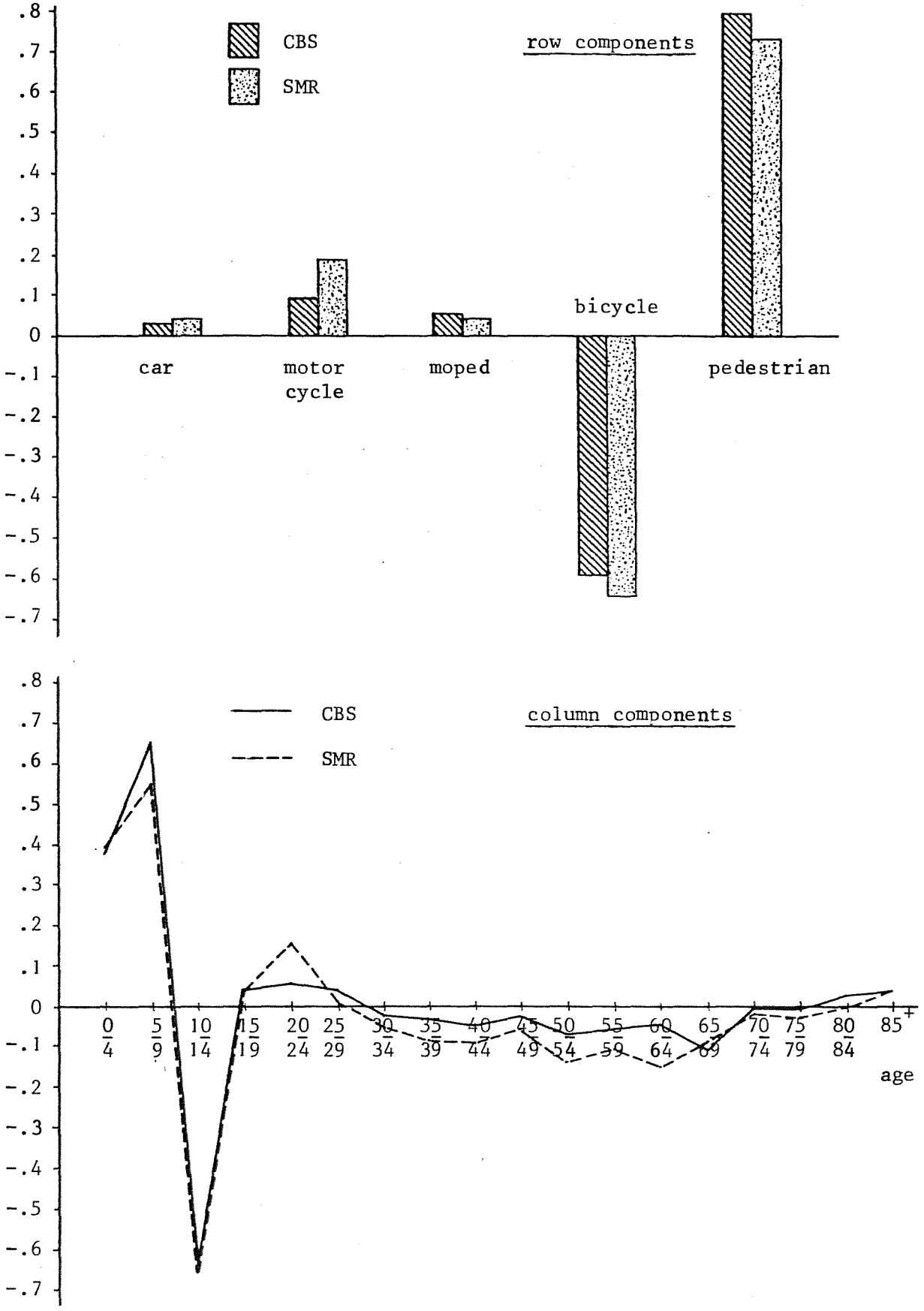


Figure 4. Eckart-Young analysis: the fourth characteristic root.

Mode of transport	Number of persons discharged	Transferred to medical-therapeutical institutions	
		abs.	%
car	7,400	367	5.0
motorcycle	1,245	64	5.1
other motorized vehicle	244	18	7.4
subtotal 'fast traffic'	8,889	449	5.1
moped	4,301	100	2.3
bicycle	4,676	83	1.8
pedestrian	2,910	89	3.1
subtotal 'slow traffic'	11,887	272	2.3
other + unknown	1,425	51	3.6
total	22,201	772	3.5

Table 1. Number and share of traffic victims (injured persons) who were transferred to another medical-therapeutical institution, according to SMR data, 1979.

	1976	1977	1978	1979
a. Number of hospitalizations, SMR	1,308,594	1,336,129	1,445,337	1,466,426
b. Total number of hospitalitions, NZI	1,487,654	1,502,610	1,532,801	1,553,369
c. Share of SMR	88.0%	88.9%	94.3%	94.4%
d. Number of persons, injured in traffic accident and hospitalized, according to SMR*	23,310	25,122	24,528	22,201
e. Idem, after correction for persons, deceased after 30 days (0.25% of d)	23,368	25,185	24,589	22,257
f. Idem, after correction for accidents on private grounds (-3% of e)	22,667	24,429	23,852	21,589
g. Total number of hospitalized traffic victims (+ corrected for the SMR share)	25,769	27,473	25,295	22,870
h. Number of hospitalized traffic victims according to police records	21,174	22,572	21,505	18,984
i. Level of police recording (h/g)	82.2%	82.2%	85.0%	83.0%

* = discharged alive

Table 2. The completeness of police records of hospitalized traffic victims.

Quarter*	1976			1977			1978			1979		
	CBS	SMR	ratio**	CBS	SMR	ratio**	CBS	SMR	ratio**	CBS	SMR	ratio**
1st	4,387	4,785	0.92 (2)	5,006	5,413	0.92 (2)	4,974	5,485	0.91 (1)	3,129	3,765	0.83 (3)
2nd	5,558	6,199	0.90 (3)	5,729	6,577	0.87 (3)	5,673	6,551	0.87 (3)	5,334	6,213	0.86 (2)
3rd	5,749	6,462	0.89 (4)	5,917	6,880	0.86 (4)	5,514	6,518	0.85 (4)	5,301	6,396	0.83 (4)
4th	5,480	5,864	0.94 (1)	5,920	6,252	0.95 (1)	5,344	5,974	0.89 (2)	5,220	5,827	0.90 (1)
total	21,174	23,310	0.91	22,572	25,122	0.90	21,505	24,528	0.88	18,984	22,201	0.86

* CBS: the quarter when the accident occurred

SMR: the quarter when the injured person was admitted to hospital

** rank numbers in brackets

Table 3. Number of traffic victims admitted to hospital per quarter according to CBS and SMR records, in the period 1976-1979.

Province*	CBS	SMR	ratio**	SMR share***
Groningen	561	853	0.66 (11)	88.7% (9)
Friesland	747	1,017	0.73 (9)	95.5% (3)
Drenthe	664	821	0.81 (6)	100.0% (1)
Overijssel	1,514	2,198	0.69 (10)	100.0% (1)
Gelderland	2,611	2,684	0.97 (3)	90.7% (8)
Utrecht	1,144	1,482	0.77 (7)	95.3% (4)
North-Holland	2,944	3,339	0.88 (4)	90.8% (7)
South-Holland	3,060	3,078	0.99 (2)	84.4% (10)
Zeeland	524	448	1.17 (1)	81.0% (11)
North-Brabant	3,346	3,889	0.86 (5)	91.6% (6)
Limburg	1,764	2,392	0.74 (8)	93.1% (5)
Southern IJssel-meerpolders	105	-	-	-
total	18,984	22,201	0.86	90.7%

* CBS: the province where the accident occurred; SMR: the province of hospital

** rank numbers in brackets

*** SMR share in the total number of 'hospital beds' (ref. SMR, 1980a)

Table 4. Traffic victims admitted to hospital according to CBS and SMR in 1979, per province, supplemented with the SMR share.

Mode of transport	1977			1978			1979		
	CBS	SMR	ratio*	CBS	SMR	ratio*	CBS	SMR	ratio*
passenger car	8,228	8,155	1.01 (2)	8,144	8,027	1.01 (1)	7,245	7,400	0.98 (1)
motorcycle	1,116	1,204	0.93 (4)	1,108	1,250	0.89 (4)	1,003	1,245	0.81 (4)
moped	5,674	5,446	1.04 (1)	5,041	5,075	0.99 (2)	4,170	4,301	0.97 (2)
bicycle	4,249	4,565	0.93 (3)	4,057	4,520	0.90 (3)	3,854	4,676	0.82 (3)
pedestrian	2,735	3,161	0.87 (5)	2,607	3,280	0.79 (5)	2,258	2,910	0.78 (5)
subtotal	22,002	22,531	0.98	20,957	22,152	0.95	18,530	20,532	0.90
other motorized vehicles**	520	216		514	205		421	244	
other road users**	13			13			14		
		2,375			2,171			1,425	
unknown	37			21			19		
total	22,572	25,122	0.90	21,505	24,528	0.88	18,984	22,201	0.86

* rank numbers in brackets

** CBS and SMR use different definitions for these groups

Table 5. Number of traffic victims admitted to hospital, broken down according to mode of transport, according to CBS and SMR records in the period 1977-1979.

Age category	1977			1978			1979		
	CBS	SMR	ratio*	CBS	SMR	ratio*	CBS	SMR	ratio*
0-14 years	3,459	4,822	0.72 (5)	3,282	4,820	0.68 (5)	2,953	4,256	0.69 (5)
15-19 years	5,898	6,233	0.95 (2)	5,674	6,107	0.93 (2)	4,990	5,539	0.90 (2)
20-34 years	6,026	6,342	0.95 (1)	5,961	6,248	0.95 (1)	5,238	5,715	0.92 (1)
35-64 years	5,087	5,490	0.93 (3)	4,589	5,270	0.87 (4)	3,935	4,685	0.84 (4)
65+	2,022	2,235	0.90 (4)	1,914	2,083	0.92 (3)	1,768	2,006	0.88 (3)
subtotal	22,492	25,122	0.90	21,420	24,528	0.87	18,884	22,201	0.85
unknown	80			85			100		
total	22,572	25,122	0.90	21,505	24,528	0.88	18,984	22,201	0.86

* rank numbers in brackets

Table 6. Number of traffic victims, broken down according to age and admitted to hospital according to CBS and SMR records in the period 1977-1979.

Sex	CBS	SMR	ratio
male	12,948	14,951	0.87
female	6,033	7,250	0.83
unknown	3	-	-
total	18,984	22,201	0.86

Table 7. Persons admitted to hospital, broken down according to sex, in 1979.

Age group	Car	Motor cycle	Moped	Bicycle	Pedes-trian	Other + unknown	Total
0- 4 years	96	1	0	32	219	5	353
5- 9 years	134	1	6	422	651	13	1,227
10-14 years	168	1	112	806	256	30	1,373
15-19 years	928	393	2,918	563	144	44	4,990
20-24 years	1,614	424	350	261	86	72	2,807
25-29 years	829	98	110	135	69	80	1,321
30-34 years	734	40	80	150	60	46	1,110
35-39 years	530	10	78	112	40	42	812
40-44 years	405	11	67	122	42	24	671
45-49 years	326	6	70	110	52	25	589
50-54 years	318	1	75	147	52	18	611
55-59 years	331	4	88	165	68	21	677
60-64 years	255	1	75	162	76	6	575
65-69 years	214	2	57	217	91	6	587
70-74 years	158	2	37	197	136	6	536
75-79 years	92	2	21	149	102	6	372
80-84 years	41	0	12	70	67	3	193
85+	14	0	2	25	38	1	80
unknown	58	6	12	9	9	6	100
total	7,245	1,003	4,170	3,854	2,258	454	18,984

Table 8. Number of traffic victims, admitted to hospital, according to CBS records, broken down according to age and mode of transport, in 1979.

Age group	Car	Motor cycle	Moped	Bicycle	Pedes-trian	Other + unknown	Total
0- 4 years	112	0	3	131	302	59	607
5- 9 years	233	8	27	629	796	140	1,833
10-14 years	225	27	181	845	377	161	1,816
15-19 years	972	440	2,859	682	269	317	5,539
20-24 years	1,504	464	398	297	111	224	2,998
25-29 years	824	154	114	187	79	122	1,480
30-34 years	723	74	79	188	72	101	1,237
35-39 years	557	32	87	160	52	82	970
40-44 years	410	18	75	160	60	71	794
45-49 years	355	12	85	140	64	61	717
50-54 years	331	3	74	183	66	54	711
55-59 years	359	5	99	204	97	53	817
60-64 years	251	2	83	205	82	53	676
65-69 years	228	3	65	232	138	56	722
70-74 years	155	1	41	195	148	58	598
75-79 years	99	1	17	144	104	28	393
80-84 years	47	0	10	74	58	18	207
85+	15	1	4	20	35	11	86
unknown	-	-	-	-	-	-	-
total	7,400	1,245	4,301	4,676	2,910	1,669	22,201

Tabel 9. Number of traffic victims (injured persons), admitted to hospital, according to SMR records, broken down according to age and mode of transport, in 1979.

Age group	Car	Motor cycle	Moped	Bicycle	Pedes-trian	Other + unknown	Total
0- 4 years	86	-	-	24	73	-	58
5- 9 years	58	-	-	67	82	-	67
10-14 years	75	-	62	95	68	19	76
15-19 years	95	89	102	83	54	14	90
20-24 years	107	91	88	88	77	32	94
25-29 years	101	64	96	72	87	66	89
30-34 years	102	54	101	80	83	46	90
35-39 years	95	-	90	70	77	51	84
40-44 years	99	-	89	76	70	34	85
45-49 years	92	-	82	79	81	41	82
50-54 years	96	-	101	80	79	-	86
55-59 years	92	-	89	81	70	40	83
60-64 years	102	-	90	79	93	-	85
65-69 years	94	-	88	94	66	-	81
70-74 years	102	-	90	101	92	-	90
75-79 years	93	-	124	103	98	-	95
80-84 years	87	-	-	95	116	-	93
85+	-	-	-	125	109	-	93
unknown	-	-	-	-	-	-	-
total	98	81	97	82	78	27	86

Table 10. CBS/SMR ratios (x 100) of injured persons, admitted to hospital in 1979, according to age and mode of traffic participation (for CBS numbers less than 20 no ratio is calculated).

THE ECKART-YOUNG ANALYSIS

From the mathematical view point an Eckart-Young analysis is a 'singular value decomposition' of the matrix X, consisting of n rows and m columns in accordance with m age categories for n modes of transport.

This matrix can always be expressed as:

$X_{n,m} = K_{n,p} \Lambda_{p,p} L^T_{p,m}$ with $K^T K = I$ and $L^T L = I$ and Λ a diagonal matrix.

The matrix X can be expressed as a sum:

$X = X_1 + X_2 + ... + X_p$, whereby p, the rank of X, $\leq r = \min(n,m)$

and

$X_i = k_i \lambda_i 1_i^T$, a matrix of rank 1, can be interpreted as the contribution of curve i to the variance in matrix X.

The sum of squares of the elements of $X - \sum_{i=1}^{s} X_i$ is continually decreasing on s progressing from 1 towards p.

Thus each matrix X_i defines an additional quantity of variance in the elements of X. The measure of contribution of X_i matrices to the explanation is in proportion with the value of λ_i; X_1 is the matrix related to the highest value of λ. The λ's form a declining series. In case $p < r$, one or more λ's will be zero.

The decomposition can be obtained, for example, by calculating the characteristic roots and characteristic vectors of $X^T X = L\Lambda K^T K \Lambda L^T = L\Lambda^2 L^T$ and calculating there from $K = XL\Lambda^{-1}$.

1_i^T can now be interpreted as the i-th basis curve; k_i can be interpreted as the vector of relative weights for modes of transport related to 1_i^T and λ_i as the absolute weight of 1_i^T.