COMMUTING ACCIDENTS IN THE STOCKHOLM REGION 1971

Bertil Aldman — Dept of Traffic Safety, Chalmers University of Technology, Gothenburg, Sweden
Åke Forsström — Dept of Human and Social Geography, University of Gothenburg
Ulf Samuelsson — Dept of Environmental Hygiene, University of Gothenburg

ABSTRACT

This is a preliminary study on an interdisciplinary project "commuting accidents". One part of the project concerns the commuting system, the other medical aspects of the accidents. The aim of the project is to study all sorts of accidents with personal injury occurring on commuting modes. The source of information is the individual reports within the compulsory health insurance regarding accidents at work in Sweden.

This preliminary study was made on commuting accidents in the Stockholm region 1971. The reason for choosing this region was that an extensive study about patterns of travelling in this region 1971 has been published. The population at risk in this investigation was those travelling to and from work, about 0.7 million people.

This study contains 1718 cases. The results are based on the method of referring each accident to its proper group in the population and then try to explain the differences in accident rates between the groups by analysing the commuting process.

The commuter´s risk of having an accident with personal injury is 8.4 for those using public means of transportation, 2.7 for car transport and 8.7 for pedestrians and two-wheelers all figures per one million travels. The high figure in the first case is explained by the method of referring each accident to its proper link in a chain of transport. The risk when walking to work and to public vehicles is 67, during travel with the vehicle it is 1, and during walk from the vehicles to work 24 per one million travelling hours.

The modal accident can be described by the following characteristics. The injured person is a woman 55 to 64 years old, who is injured in an accident by falling to the ground, while she is late and rushing to a bus-stop in order to get to work. She is having skeletal injuries in her hand, which is characterized as AIS 3 and causes her between 35 and 49 days of impairment.

1 THE PROBLEM AND THE SOURCE OF INFORMATION

The official statistics on traffic accidents are usually biased towards the influence of motor vehicles. In order to avoid some of the problems from this bias, we have chosen to investigate the individual reports on commuting accidents within the compulsory health insurance regarding accidents at work in

Sweden.

This source of information includes all commuting accidents with personal injury. One advantage of using this source is that it contains information about all sorts of traffic accidents including for instance those involving track-bound vehicles and all accidents for pedestrians even those in which there is no motor vehicle involved.

Due to the difference in definition between this type of accident and the statistically well defined term traffic accident, we have chosen the term commuting accident for the object of our study. We believe, however, that by this study we have put some light on some rather unknown accidents which do occur in the traffic.

The insurance reports have a description of the accident, medical diagnoses and information about the number of days of impairment. They are made up by the employer in cooperation with the employee on all accidents resulting in at least one day of impairment.

2 THE PROJECT "COMMUTING ACCIDENTS"

The project "Commuting Accidents" is planned to contain studies on the commuting accidents in four counties in Sweden in 1971, a study of the Gothenburg region for 1976, a checking investigation on the reliability of the information source, and two intensive studies on particular commuting and medical aspects.

The four counties include both the largest and some of the smallest communes in Sweden. It is therefore possible to study regional differences in accidental risks. A preliminary study was made in one county which mainly consists of the Stockholm region. The size of the working population in this region was about 0.7 million people.

3 THE POPULATION

The number of cases was 1718. The study in the Stockholm region contains all persons injured in commuting accidents in 1971, living in the Stockholm county, excluding the communes of Södertälje, Norrtälje and Nynäshamn and a few small border parishes and with the employer´s head office localized in Stockholm.

Every person, who is injured in a commuting accident is an individual in a statistical sence. Very few accidents resulted in more than one injured person.

4 THE RELIABILITY

The reliability must be judged from different analyses. There is a spatial and a temporal problem and a question of definition. Injured persons whose employers are localized outside the region were not included. The temporal problem was easy to solve because every report includes the date for the accident.

It is possible that very slightly injured persons did not report the accident. This is, however, not very likely because of the possibility of future complaints, which would be covered by industrial injuries insurance. This problem is, however, now being checked.

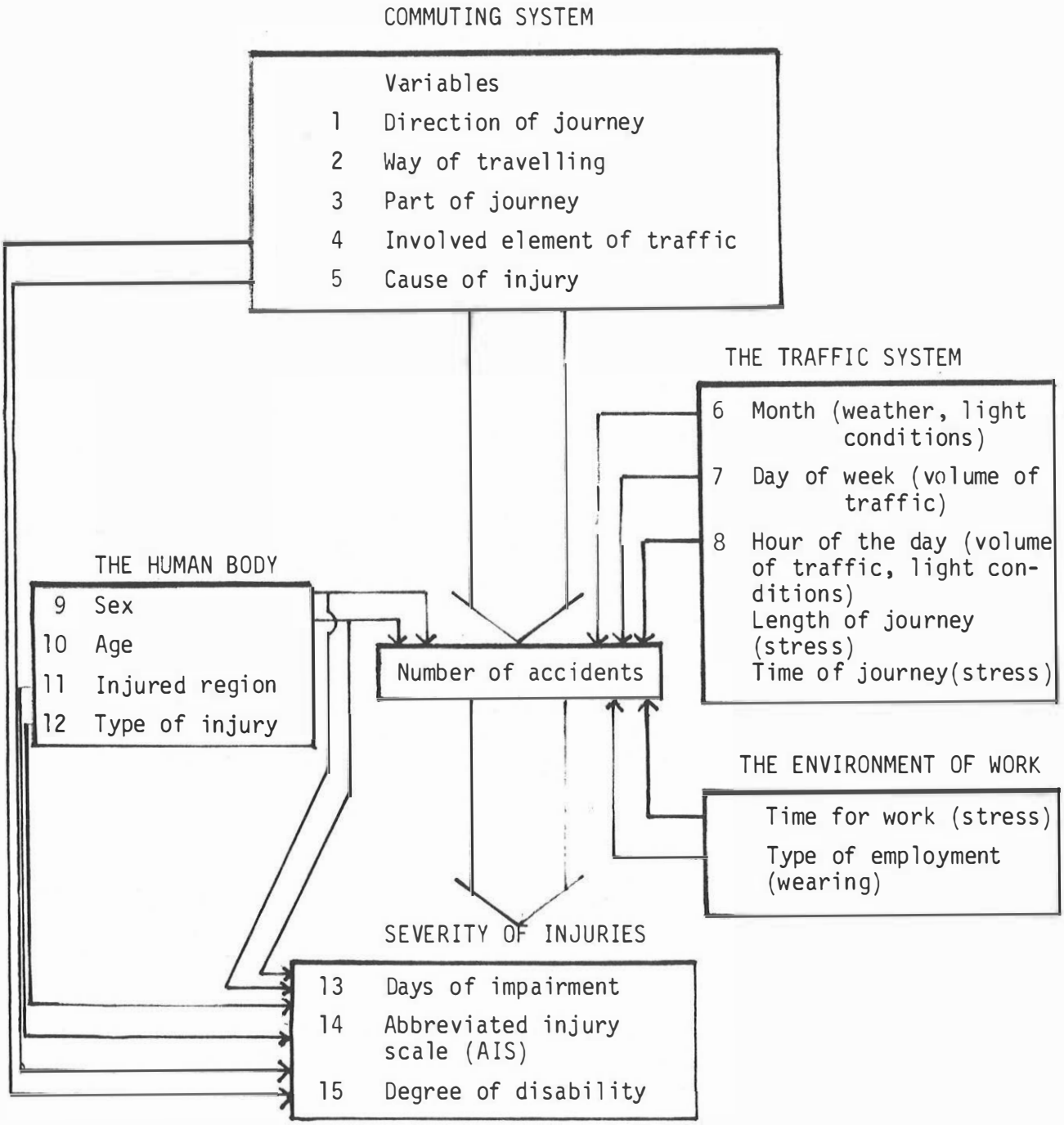

Figure 1 Model and variables of commuting accidents

The variables in the commuting system are supposed to be parts of a process that leads to an accident in the order indicated by the figure of the variables.

The arrows show the hypothetic impact on either the number of accidents or the severity of injuries.

As a whole we believe that the study has a good reliability.

5 METHOD

The method consists of a number of subsequent steps. The image of reality was formulated in an a priori model. Hypotheses were formulated. An experiment situation was designed including definition, measurements and classifications.

Data were measured in the individual reports, which were assembled. Data were arranged, classified and described in accordance with this problem. Finally the hypotheses were evaluated.

The function of the model was to serve as a frame for the relevant variables and their interaction in the accident process. We did not actually test the construction of the model. We evaluated the relevance and the importance of the variables.

6 THE BASIC MODEL OF COMMUTING ACCIDENTS

When building the model of commuting accidents we had our elements from the commuting journey. The question is the way of travelling, the travelling direction, at which part of the journey the accident occurred, if any element of traffic was involved and what object actually caused the injury. This was a subsystem in the model, called the single journey´s commuting system.

Besides, there were three other subsystems, the traffic system, the environmental work system and the human body. As seen by figure 1 we were only able to measure the functioning of those systems in an indirect way. The individual reports were not detailed enough for direct approach.

The major elements of the traffic system were the local weather conditions, the volume of traffic and the light conditions at the site of the accident. These were measured in an indirect way by the month, day and time.

The environmental system at the place of work have elements not described in the reports.

The complicated system of the human body could only be hinted. Sex and age were ways of measuring the strength and the fragility of the bones. The differences between various parts of the body were measured by the injured region. The importance of the type of the injury was also measured.

The severity of injury were measured by the number of days of impairment and by the abbreviated injury scale.

The situation in figure 1 has no dimensions in time or space. The commuting system, however, can be given a geographical dimension. In order to use the main facilities for travelling one has to walk to a terminal, use a vehicle and walk again to the final destination.

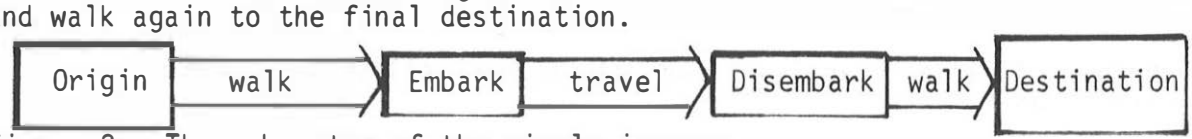

Figure 2 The subsystem of the single journey

There are of cause more complex variations on this theme, but the important thing here is to include walks as an unavoidable part in a commuter´s chain of travel.

7 HYPOTHESES

At this early stage of an investigation we have not yet reached the level of scientific explanation when a phenomenon should be explained.

However, as sketched in the description of the method hypotheses stated or not, have great influence on the choice of variables, classification procedures.

The hypotheses are simply that the variables from 1 to 10 have an "explanatory" value for the number of accidents and that the variables with figures 4 to 12 may contribute to the explanation of the number of the days of impairment.

We did expect a high frequency of accidents for car commuters and a low one for commuters with public means of transportation. We also expected a high figure for younger men and not a particularly high figure for older women.

As our investigation contained all cases and no sampling procedure was used we did not test our hypotheses statistically.

8 A SHORT DESCRIPTION OF THE ACCIDENTS

The first step in the analysis was performed with one variable at a time. It began with the commuting system, proceeded with the environmental variables and ended with a medical description and consequences.

The population contains 1718 cases including 8 cases of death and 35 cases of permanent disability.

The number of missing data were relatively low for most of the variables. Ways of travelling were unknown in 11.0 percent of the cases and the exact time of the day in 4.6 percent. Two variables missed in 2.3 percent and the remaining variables in less than 1 percent.

The distribution of the number of cases on the time of impairment was very skewed. The mode was 1-7 days of impairment, the median 11 days and the mean 37 days. The distribution of the number of days of impairment on the same variable moves the median to 12 weeks. This implies that 97 percent of the cases have 50 percent of the time of impairment. Number 2 on the abbreviated scale was both mode, median and mean.

9 A GENERAL OVERVIEW OF THE IMPORTANCE OF THE VARIABLES

All variables are relevant for the model. They do have an impact on the frequences, the number of days of impairment and the injury-scale. The number of cases in different situations depend on one set of variables and the days of impairment on another set. One variable can be member of both sets.

The technique of variance analysis was used to rank all variables and to identify the later set.

Six variables had an explanatory value for the time of impairment.Five of those

variables type of injury, region injury, involved element of traffic, age, cause of injury are supposed to have an impact on the time of impairment in the model. Month is the only variable not included in the model.

A frequency analysis revealed variables, in which frequency more than average time of impairment effected the total time. The variables in the commuting system were highly oriented towards frequency of accidents. The variables in the traffic system, day and time were also included in that group. Sex is definitely of importance for the frequency of accidents. Three variables have impacts on both frequency and the time of impairment. These are month, involved element of traffic and cause of injury.

The two techniques of analysis supplement each other. The results confirm the hypotheses and indicate the main order in which the analysis of the variables should be made.

11 THE COMMUTING SYSTEM

The simple frequency distribution of the direction of travelling showed a somewhat unexpected result. The journeys to work contain 59 percent of the accidents while the accidents on journeys from work were 41 percent. This difference in absolute figures was not explained by calculations of risks. Journeys to work run a risk of 8.0 compared with 6.2 for journeys from work, all per one million journeys.

The distributions of facilities of travels were even more unexpected. Public means of transportation had a very high accident number.

Table 2 The number of accidents distributed on way of travelling and direction

Direction	Way of travelling					
	Public	Car	Two-wheeler	Pedestrian	Other	All cases
To work	502	148	99	145	114	1008
From work	315	105	101	87	102	710
All cases	817	253	200	232	216	1718

Touring to work had a higher frequency of accidents for all ways of travelling except two-wheelers.

The calculated risk figures did not change the picture in the relation of public transportation and car.

Table 3 Accidental risk figures distributed on way of travelling and direction (per one million journeys)

Direction	Way of travelling		
	Public	Car	Two-wheeler, pedestrian
To work	9.3	3.1	9.5
From work	6.9	2.3	7.1

It was not possible to separate two-wheelers and pedestrians. The risk for that group are equal with the risks in the public transportation group.

The inclusion of the variable "part of journey" explained the high risk for

public transportation. The walks to and from stopping places were very riskful. The risk figures for travelling by vehicle are of course not direct comparable with the risk figure for walking to and from vehicle. The differences in speed

Table 4 Accidental risk figure distributed on way of travelling, part of journey and direction (per one million hours of travel)

Geogr base	Way of travel	Part of journey: To/from vehicle	Travel	To/from vehicle	Geogr base
Residence	Public	67	1	24	Workplace
		26	2	29	
	Car	14	8	7	
		17	5	5	

make the figures unrelateable.

The combination to work and to vehicle is the most dangerous part of a journey for a commuter with public means of transportation. On the way back from work there is a slight increase in the risk when walking to the vehicle.

For car commuters the highest risk is combined with journeys from work and from a parking place. There is also the wellknown higher risk figure connected with the actual car trip.

One might analyse how the risks were distributed on different groups of sex and age to explain the difference between the two types of commuters. The account of data in the named traffic investigation does not permit such an analysis. It was not possible to calculate comparable risk figures for pedestrians and two-wheelers.

It is obvious that the highest risks are connected with that part of a journey when the commuter is on foot.

Table 5 Number of accidents while the commuter is on foot

Accident place or situation	Frequency	Percent
On the street, while walking to and from the vehicle	790	45.9
On parking and stopping places	234	13.6
Walking as pedestrian	232	13.5
Total	1256	73.0

The accident situation can be further analysed by asking if any other traffic element was involved. The popular image of an accident involves a vehicle.

In the overwhelming part or 77 percent, of the total number of accidents no other traffic elements are involved and mainly concerns commuters on foot.

The most frequent cause of injury is falling on existing level. It contains 56 percent of all cases or for commuters on foot 60 percent.

Table 6 Number of accidents after involvement of other elements of traffic

Type of involvement of traffic elements	Commuters on foot	Vehicles	All cases
Other traffic elements involved	109	228	335
No other traffic elements involved	1114	186	1328
Other physical obstacles	33	11	45
All cases	1256	425	1718

A summary shows that commuters on foot have very high risk figures especially in connection with travel by public means of transportation. The resulting accidents are mostly single and are caused by a fall to the ground.

12 AN ANALYSIS OF POPULATION GROUPS

An analysis of population groups was based on sex and age. Each sex was divided into two groups by the age of 45 years. The figures must be interpreted with care. Part time working people (about 10 percent) were not included in the masses of risk.

Table 7 Risk figures distributed on population groups (per 10,000 working people)

Sex	Age	
	Less than 45	45 or more
Men	16	24
Women	19	67

Note: The figures are not comparative with those in table 8. Older women showed very high figures. The way of travelling did not explain the differences between this group and the other groups.

Table 8 Risk figures distributed on sex and ways of travelling (per 10,000 working people)

	Sex		
	Men	Women	All cases
Public	18	41	30
Car	9	10	9
Pedestrian, two-wheeler	31	28	29
All cases	18	33	25

Note: The figure are not comparable with table 7.

The conclusion from table 8 is that the use of public means of transportation is more dangerous for women than for men.

The account of data did not permit a differentiation on age.

13 MEDICAL ASPECTS

When the commuting process actually led to an accident with personal injury,

the variables that completed the process had an increasing degree of impact on time of impairment. The difference between the class means were increased. Two or three classes of each variable dominated the material.

Table 9 Mode and second mode for variables acting after the injury (percent of total

Variable	Mode Class	Mode Frequency	Mode Days of impairment	Second mode Class	Second mode Frequency	Second mode Days of impairm.
Element of traffic	Single	77	68	Car	15	21
Cause of injury	Fall on exist level	56	51	Vehicle	17	21
Region of injury	Knee,leg	19	30	Foot	19	13
Type of injury	Skeletal	38	68	Distorsion	34	17
Age	55-64 years	32	41	45-54 years	27	27

As seen from the table the dominating single accidents were not harmless. They had a mean time of impairment of 32 days. The two classes single accidents and fall on existing level are covering each other. The class fall etc contains 51 percent (of total) of single accidents.

Cause of injury determins region and type of injury. The accidents caused by falls and vehicles are distributed evenly over various parts of the body. The time of impairment follows the frequency distribution.

Table 10 Distribution of frequency and time of impairment for accidents caused by fall and vehicle on region of injury (percent of total)

	Region of injury							
	Arm		Hand		Knee,leg		All cases	
Cause of injury	Freq-uency	Days of imparm.	Freq-uency	Days of impairm.	Freq-uency	Days of impairm.	Freq-uency	Days of impairm.
Fall on existing level	12	13	13	10	10	12	56	51
Vehicle	2	2	2	1	4	9	17	21
All cases	16	19	18	14	19	30	100	100

The distribution of the same accidents on the type of injury reveals bigger differences between frequencies and time of impairment. There was also a concentration of the cases on one class contain fractures. These variations make this variable as well as the AIS-variable a good predictor of the time of impairment.

Table 11 Distribution of frequencies and time of impairment for accidents caused by fall and vehicle on type of injury (percent of total)

	Contusions		Distorsions		Fractures		All cases	
Cause of injury	Freq-ency	Days of impairm	Freq-uency	Days of impairm	Freq-uency	Days of impairm	Freq-uency	Days of impairm.
Fall on level	7	3	18	8	24	38	56	51
Vehicle	3	1	3	6	6	13	17	21
All cases	12	5	34	17	38	68	100	100

Age has for obvious reasons a differentiating effect on the two main causes of injury.

Table 12 Distribution of frequencies and time of impairment for accidents caused by fall and vehicle on age (percent of total)

	Age					
	Under 45 years		45 years or more		All cases	
Cause of injury	Frequency	Time	Frequency	Time	Frequency	Time
Fall on existing level	16	9	40	42	56	51
Vehicle	10	8	8	13	17	21
All cases	36	24	64	76	100	100

A typical commuter with personal injury was a middle aged female, who fell to the ground in a single accident, who had a fracture in the bones of the hand and had about 40 days of impairment.

14 SUMMARY

The summary is concentrated to one group of the population, women who commute with public means of transportation. They were 21 percent of the working population but they had 38 percent of the time of impairment.

This difference depends on a higher risk-figure and a longer average time of impairment.

The female, public commuter had an accidental risk of 41 per 10 000 working people and an average time of impairment of 40.4 days. The respective values for all other commuters on every mode of travel are 21 and 35.7. If the group of public commuting females had the same values they would have saved about 13,000 days of impairment.

This study did not explain this difference, but the result hints that the strategic parts of the journey are the walks to and from the stopping-places. Especially dangerous was the walk to the stopping-place and to the work.

REFERENCE

STOCKHOLMS LÄNS LANDSTING (1973): Trafikundersökningar i Stockholmsregionen hösten 1971 (Traffic Investigations in the Stockholm Region. Autumn 1971)